RECONNAISSANCE OF IRON OCCURRENCES IN COLORADO

By C. M. Harrer and W. J. Tesch, Jr.

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CONTENTS

	Page
Summary	1
Introduction	2
Acknowledgments	2
History, production, and use	2
Geography	4
Iron minerals	8
Limonite	8
Hematite	8
Magnetite	9
Siderite	9
General geology	9
Pyrite	9
Limonite	9
Hematite	10
Magnetite	10
Siderite	11
Mining operations	11
Iron occurrences by counties	12
Boulder County	12
Caribou titaniferous magnetite	12
Miscellaneous siderite-limonite-hematite concretions	13
Miscellaneous hematite and magnetite	13
Chaffee County	14
Boss Lake magnetite	14
Calumet-Hecla-Smithville magnetite	14
Iron King (Hawkins)hematite	17
Mineral Basin magnetite	18
Miscellaneous iron occurrences	18
Clear Creek County	19
West Geneva Creek limonite	19
Miscellaneous magnetites	20
Costilla County	21
Star of the West magnetite	21
Trinchera Ranch titaniferous magnetite	23
Miscellaneous iron occurrences	24
Custer County	24
Wahl mine manganiferous limonite	24
Delta County	25
Delta (Iron Cap, Mingen) limonite	25
Dolores County	26
Rico Spring and bog limonite	26

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CONTENTS (Con.)

	Page
Miscellaneous iron occurrences	27
Rico pyrite-hematite	27
Eagle County	27
Miscellaneous iron occurrences	27
El Paso County	29
Miscellaneous iron occurrences	29
Fountain Creek magnetite	29
Fremont County	29
Iron Mountain titaniferous magnetite	29
Miscellaneous iron occurrences	30
Canon City limonite-siderite	32
Garfield County	32
Glenwood Springs limonite	32
Gilpin County	32
Miscellaneous iron occurrences	32
Gunnison County	33
Cebolla Creek titaniferous iron occurrences	33
Crested Butte limonite	34
Cumberland magnetite	35
Iron King magnetite	37
Iron-ore lode magnetite	38
Mount Tilton magnetite	40
Redwell Basin limonite-hematite	40
Taylor Peak magnetites, southeast slope	41
Twenty Percent Creek magnetite	41
Fossil Ridge magnetite	42
Carbonate Camp hematite	42
Miscellaneous iron occurrences	42
Hinsdale County	44
Wager Gulch limonite	44
Huerfano County	44
Walsenburg limonite-siderite	44
Jefferson County	45
Kennedy Gulch magnetite	45
Jefferson County iron mines	45
Miscellaneous iron occurrences	45
Lake County	45
Leadville iron occurrences	45
Miscellaneous iron occurrences	47
La Plata County	48
Babcock Peak magnetite	48
Larimer County	48
Langford-Trail Creek magnetite	48
Miscellaneous iron occurrences	48
Las Animas County	49
Trinidad limonite-siderite	49
Moffat County	49
Paint Iron mine hematite	49
Miscellaneous iron occurrences	51

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CONTENTS (Con.)

	Page
Montezuma County	51
Indian Trail Ridge magnetite	51
Rush Basin bog limonite	51
Ouray County	52
Dunmore mine hematite	52
Guston mine limonite	52
Ironton Park limonite	53
Miscellaneous iron occurrences	53
Park County	53
Tarryall Creek mining district magnetite	53
Handcart Gulch-Hall Valley limonite	54
Miscellaneous magnetites	56
Pitkin County	56
Cooper Creek magnetites	56
Coopers Fork Creek magnetite	57
Miscellaneous iron occurrences	58
Pueblo County	59
Overton-Steele Hollow limonite-siderite	59
South of Pueblo, limonite-siderite	59
Saguache County	59
Alder limonite	59
Del Norte limonite	61
Indian Creek limonite	62
Kerber Creek limonite	62
Major Creek limonite mine	62
Orient limonite-hematite mine	65
San Juan County	67
Burro Bridge limonite	67
Cement Creek bog limonite	68
Chattanooga limonite	68
Mineral Creek limonite	70
Silverton Reservoir limonite	70
Miscellaneous iron occurrences	71
San Miguel County	72
Chapman Gulch limonite	72
Ferric Oxide limonite	72
Iron Springs limonite	73
Summit County	75
Snake River bog limonite	75
Miscellaneous magnetite and hematite	76
Bibliography	77

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ILLUSTRATIONS

Fig.		Page
1.	Map showing location of iron occurrences in Colorado.	5
2.	Boss Lake magnetite deposit, Chaffee County, Colo....	15
3.	Calumet-Hecla-Smithville magnetite, Chaffee County, Colo.....	15
4.	West Geneva limonite, Clear Creek County, Colo.....	19
5.	Star of the West magnetite, Costilla County, Colo....	21
6.	Horizontal bed of limonite, Delta deposit, Delta County, Colo.....	25
7.	Cumberland magnetite pit, Gunnison County, Colo.....	36
8.	Iron-Ore Lode magnetite outcrop, Gunnison County, Colo.....	39
9.	Mount Tilton magnetite, Gunnison County, Colo.....	39
10.	Paint hematite mine, Moffat County, Colo.....	50
11.	Old workings and limonite in creek bed near head of Handcart Gulch, Park County, Colo.....	55
12.	Coopers Fork magnetite deposit, Pitkin County, Colo..	57
13.	Alder limonite deposit, Saguache County, Colo.....	60
14.	Del Norte limonite deposit, Saguache County, Colo....	60
15.	Kerber Creek limonite exposure along Villa Grove-Bonanza road, Saguache County, Colo.....	63
16.	Major Creek limonite deposit, Saguache County, Colo..	64
17.	Orient Mine, Saguache County, Colo.....	66
18.	Chattanooga limonite deposit, San Juan County, Colo..	69
19.	Mineral Creek bog iron deposit near Silverton, San Juan County, Colo.....	69
20.	Silverton Reservoir limonite deposit, Silverton, San Juan County, Colo.....	71
21.	Limonite outcrop, Ferric Oxide claim, Old Ophir, San Miguel County, Colo.....	73
22.	Iron Springs limonite deposit, Old Ophir, San Miguel County, Colo.....	74

TABLES

1.	Production of iron ore from Colorado mines, 1870-1956	4
2.	Iron occurrences in Colorado.....	6
3.	Horizontal extent of eight Caribou Hill titaniferous magnetite deposits.....	12
4.	Measured section Calumet-Hecla-Smithville magnetite ore body.....	16
5.	Chemical analyses of ore from Calumet-Hecla-Smithville magnetite.....	17
6.	Chemical analyses of Iron King hematite.....	17
7.	Surface dimensions of West Geneva limonite iron deposits.....	20
8.	Analyses of ore from Star of the West magnetite deposit.....	22

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TABLES (Con.)

		Page
9.	Analyses of Trinchera Ranch titaniferous magnetite..	23
10.	Spectrographic analysis of Trinchera Ranch titaniferous magnetite.....	23
11.	Analyses of Wahl mine limonite.....	24
12.	Spectrographic analysis of Wahl mine limonite.....	24
13.	Analyses of samples from Delta limonite deposit.....	26
14.	Analyses of ore from Red Cliff limonite-siderite deposits.....	28
15.	Analyses of Iron Mountain titaniferous magnetite....	31
16.	Analyses of Cebolla Creek titaniferous magnetite....	34
17.	Analyses of limonite from Crested Butte.....	35
18.	Analyses of magnetite from Cumberland deposit.....	36
19.	Analyses of Iron King magnetite deposit.....	38
20.	Analyses of magnetite from Iron-Ore outcrop.....	38
21.	Analyses of magnetite from Taylor Peak deposit.....	41
22.	Analyses of iron ores from mines of Leadville district.....	47
23.	Analyses of limonite-siderite concretions, El Moro mine.....	49
24.	Analyses of limonite from Handcart Gulch-Hall Valley deposits.....	56
25.	Analyses of limonite from Alder deposit.....	61
26.	Analyses of ore from Orient mine.....	67
27.	Analyses of limonite from Snake River deposits.....	76

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by

C. M. Harrer[2/] and W. J. Tesch, Jr.[2/]

SUMMARY

This paper describes the location and general features of iron occurrences in Colorado. Most of the deposits were examined; many are in forested and mountainous areas at altitudes of 5,000 to 13,700 feet. Iron is known to occur in 30 counties of western Colorado.

Transporting the ore to market is a handicapping economic factor involving long truck and railroad hauls; the nearest purchaser of smelting ores is the Colorado Fuel and Iron Corp., at Pueblo, Colo. When the ore can be sold locally for special purposes and at higher prices than can be obtained at iron smelters, small-scale operations can supply that market.

Iron was noted in many places in Colorado before 1870. Records of iron-ore production are not complete, but available information indicates that a total of about 6 million tons was produced between 1870 and 1956. It was used for manufacturing iron and steel, as heavy aggregate, for pitments, as a soil conditioner, and as flux in smelting nonferrous ores.

Iron occurs as magnetite, hematite, and limonite in replacement-type contact-metamorphis deposits in limestone associated with dioritic intrusives; as magmatic segregations of magnetite that is often titaniferous; as irregular bodies of iron carbonates oxidized to limonite and hematite; and as inorganic or biogenic precipitates in swamps and around iron-charged springs.

The ore was mined by opencut, simple gophering, open-stoping, room-and-pillar, and square-set-stoping methods.

A few old mines and undeveloped deposits still contain moderate reserves of iron ore, and significant reserves might be developed in some known but inadequately explored deposits. Some deposits have high sulfur, phosphorus, and titanium contents, and many will require beneficiation to make their ores marketable.

1/ Work on manuscript completed July 1958.

2/ Mining engineer, Bureau of Mines, Region III, Denver, Colo.

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Because of the huge tonnages of iron ore a modern steel industry requires, the iron occurrences now known in Colorado are too small to be dependable sources of ore supply. Some deposits, however, will continue to be worked as special uses for their products encourage miners to exploit them.

INTRODUCTION

This paper is one of a series of Bureau of Mines publications on the mineral resources of the Nation. It describes the history, location, general features, and treatment of iron occurrences in Colorado. In preparing this report published information was used freely, and proper credit has been given. An attempt was made to describe all known occurrences of iron in Colorado, but there probably are deposits in the State on which no information has been published or which are unknown to present local residents and therefore are not covered.

The investigation was begun in August 1957 and completed in 1958. Open mine workings were examined; but most of the mines had been abandoned for many years, and their underground workings had caved and were inaccessible. Character samples of the iron minerals were analyzed in the Bureau of Mines laboratories at Salt Lake City, Utah. It would have been desirable to take samples more representative of the material that could be mined, but this could not be done without core- or auger-drilling the deposits.

An attempt was made to give exact locations of the iron deposits so that interested persons can examine them. Old descriptions of some deposits and their locations were so vague that they were difficult to find; in some instances it was impossible to find them.

ACKNOWLEDGMENTS

Acknowledgments are due the many public-spirited local residents who either furnished directions or served as guides to iron occurrences. Maps and publications of the Federal and Colorado State Geological Surveys and maps of the Forest Service and Colorado State Highway Department were used in this work. County officials were contacted and their records examined. The many other references consulted are listed in the bibliography.

HISTORY, PRODUCTION, AND USE

The first iron was produced in Colorado by W. S. Marshall in 1872 at Marshall (Langford), Boulder County, where Marshall and the Belle Monte Furnace, Iron and Coal Co., operated a charcoal-iron furnace for several months and produced 250 tons of pig iron from limonite concretions found in the nearby Cretaceous coal measures. The average furnace charge to produce 1 ton of pig iron was 3 tons of ore, 200 pounds of limestone, and 130 to 150 bushels of charcoal.

The Colorado Coal and Iron Co. was organized January 23, 1880, and established the iron and steel industry at Pueblo. In 1892 this company became the Colorado Fuel and Iron Co., and since 1936 it has been known as the Colorado Fuel and Iron Corp.

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Production of iron ore in Colorado through 1956 was about 6 million tons: About 2,100,000 tons of hematite, limonite, and magnetite, used in manufacturing iron and steel; 40,000 tons of titaniferous magnetite, used for heavy aggregate in the oil industry; 15,000 tons of limonite, hematite, ocher and bog-ore limonite, used for pigment in paint and concrete and as a conditioner for iron-deficient soils; 810,000 tons of manganiferous ore, used for making ferromanganese and spiegeleisen; and about 3 million tons used as flux in nonferrous ore smelters in the State.

During 1878-86 the ore came principally from the Calumet-Hecla-Smithville magnetite deposit in Chaffee County, the Star of the West magnetite deposits in Costilla County, the Orient limonite-hematite deposits in Saguache County, the Cebolla Creek (Iron Hill) magnetite in Gunnison County, and the Grape Creek (Iron Mountain) magnetite deposit in Fremont County.

During 1887-90 magnetite, hematite, and manganiferous ores (brown ore-limonite) from the Breece iron mine and others in the Leadville district, Lake County, were used for producing iron. The total quantity is not known.

From 1891 to 1925, 810,000 tons of manganiferous iron ore was produced from Leadville mines for manufacturing ferromanganese and spiegeleisen, and 2,900,000 tons of iron-silver and iron-manganese-silver ores was produced and used within the State as flux in the nonferrous-ore smelters. The ores consisted of limonite (brown ore), specular hematite, and magnetite; between 1915 and 1925 the content of the ore was reported as 30-44 percent iron, 12-16 percent manganese, 11-18 percent silica, 0.7-2.1 percent lead, 0.001-0.014 ounce of gold, and 5.5 ounces of silver a ton. The mixed magnetite and hematite ores taken from the Breece and other Leadville mines and shipped to iron-ore smelters assayed up to 68.3 percent iron.

Around 1890 the Delta brown-ore limonite deposit in Delta County was mined as flux for the nonferrous-ore smelters at Salida and Gunnison. Reportedly, as much as 100,000 tons of this ore, containing about 56 percent iron, was produced, but this could not be verified.

Manganiferous-iron ore, mined from the Red Cliff district, Eagle County, was used as a flux in nonferrous-ore smelters. A character sample of ore of this type (G.A. Muilenburg, 1919) assayed 37.6 percent iron, 18.6 percent manganese, 3.04 percent silica, 0.961 percent sulfur, and 0.023 percent phosphorus.

In 1924 the Wahl mine in Custer County was the source of 4,319 tons of limonite (brown ore). The ore contained 40 percent iron and was smelted in the State for its iron.

The Orient iron mine was operated almost continuously from 1880 to 1931. The total mine production was 1,700,000 tons of limonite-hematite ore. Operations were stopped in 1931, and all equipment has been removed from the property.

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During 1880-1900 the Colorado iron industry depended entirely on local iron ores. Since 1900 the local iron and steel industry, principally represented by the Colorado Fuel and Iron Corp., began to import most of its iron-ore requirements. The Wahl mine (closed in 1924), in Fremont County, and the Orient mine (closed in 1931), in Saguache County, were the last Colorado iron-ore mines of any size to be operated. Since 1931 iron ore has been produced only for special uses, such as road metal, heavy concrete aggregate, paint and concrete pigments, and soil conditioner, particularly for iron-deficient soil and that in fruit orchards.

Iron ore produced from Colorado is summarized in table 1.

TABLE 1. - Production of iron ore from Colorado mines, 1870-1956

Type of ore	Use	Thousand tons
Hematite, limonite, magnetite.....	Manufacturing iron.....	2,100
Magnetite.....	Heavy aggregate.....	40
Limonite, hematite, ochre, bog ore	Pigment, soil conditioner.....	15
Manganiferous..... (limonite, hematite)	Ferromanganese, spiegeleisen....	810
Iron-silver-manganese ore..... (limonite, hematite)	Flux.....	2,900
Brown ore, limonite.....	do.....	100
Total.....		5,965

GEOGRAPHY

Iron deposits are distributed widely throughout 30 counties of western Colorado. Those described in this report are listed in table 2 and located on figure 1. The deposits are generally in mountainous terrain at altitudes of 5,000 to 13,700 feet. Mild winters are usual at the lower altitudes, but rigorous winters and heavy snows occur at the higher altitudes. Some of the iron deposits are difficult to reach, and from many of them long truck and railroad hauls are required to deliver the ores to markets. The high cost of transportation is one of the handicaps to exploitation.

The iron and steel industry of Colorado is centered in the Colorado Fuel and Iron Corp., at Pueblo. Other, but more distant, smelters are operated by the Columbia-Geneva Steel Division, United States Steel Corporation, at Provo, Utah; Lone Star Steel Co., at Daingerfield, Tex.; Sheffield Steel Co., at Houston, Tex.; and Kaiser Steel Corp., at Fontana, Calif.

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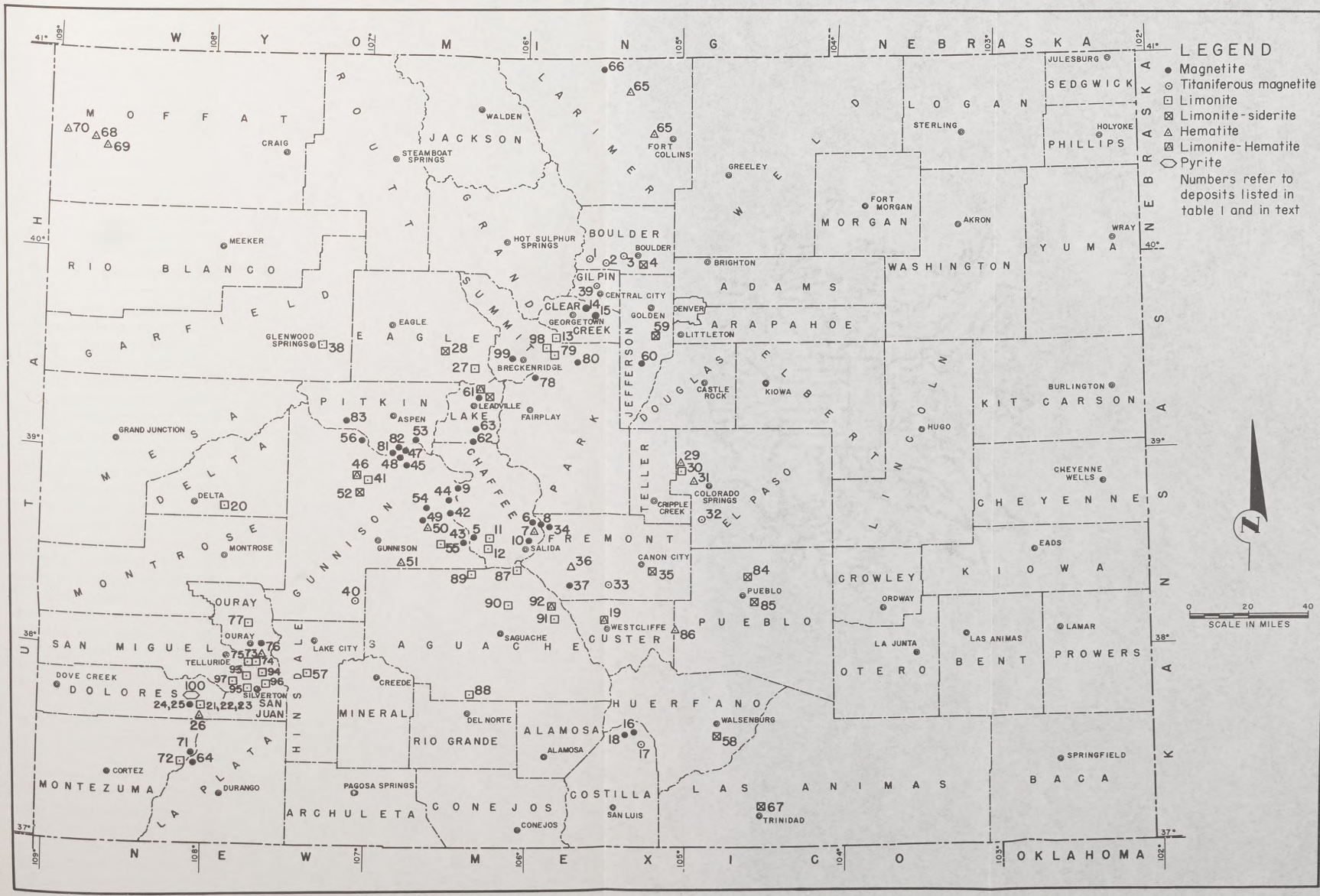

FIGURE 1. - Map Showing the Location of Iron Occurrences in Colorado.

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TABLE 2. - Iron occurrences in Colorado

(1/)	Name of deposit	County
1	Caribou titaniferous magnetite	Boulder.
2	Beaver Creek magnetite	Do.
3	Red Signe and Eagle Rock magnetite	Do.
4	Boulder limonite-siderite	Do.
5	Boss Lake magnetite	Chaffee.
6	Calumet-Hecla-Smithville magnetite	Do.
7	Iron King hematite	Do.
8	Bald Hill magnetite	Do.
9	Mineral Basin magnetite	Do.
10	Cottonwood Creek magnetite	Do.
11	Lilly mine limonite	Do.
12	Madonna mine limonite	Do.
13	West Geneva Creek limonites	Clear Creek.
14	Little Bear Creek magnetite	Do.
15	Trail Creek magnetite	Do.
16	Star of the West magnetite	Costilla.
17	Trinchera titaniferous magnetite	Do.
18	Talmich Gulch magnetite	Do.
19	Wahl manganiferous limonite-hematite	Custer.
20	Delta limonite	Delta.
21	Rico limonite	Dolores.
22	C. H. C. Hill limonite	Do.
23	Nigger Baby Hill limonite	Do.
24	Eagle prospect magnetite	Do.
25	Magnet prospect magnetite	Do.
26	Atlantic Cable hematite	Do.
27	Pando limonite	Eagle.
28	Red Cliff manganiferous limonite	Do.
29	Fountain Creek hematite-goethite	El Paso.
30	Talca Gulch limonite-ochre	Do.
31	Manitou Springs hematite-goethite	Do.
32	Fountain Creek magnetite	Do.
33	Iron Mountain titaniferous magnetite	Fremont.
34	Badger Creek magnetite-hematite	Do.
35	Canon City limonite-siderite	Do.
36	Cotopaxi hematite	Do.
37	Cotopaxi magnetite	Do.
38	Glenwood Springs limonite	Garfield.
39	Missouri Creek magnetite	Gilpin.
40	Cebolla Creek titaniferous magnetite	Gunnison.
41	Crested Butte limonite	Do.
42	Cumberland magnetite	Do.
43	Iron King magnetite	Do.
44	Iron-Ore lode magnetite	Do.
45	Mount Tilton magnetite	Do.
46	Redwell Basin limonite	Do.
47	Taylor Peak magnetite	Do.
48	Twenty Percent Creek magnetite	Do.
49	Fossil Ridge magnetite	Do.

1/ Numbers in this column refer to locations on fig. 1.

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TABLE 2. - Iron occurrences in Colorado (Con.)

(1/)	Name of deposit	County
50	Carbonate Camp hematite	Gunnison
51	Cochetopa Creek hematite	Do.
52	Mount Carbon limonite-siderite	Do.
53	Elk Mountain magnetites	Do.
54	Tincup district magnetite-hematite	Do.
55	Tomichi Creek limonite	Do.
56	Snowmass magnetite	Do.
57	Wager Gulch limonite	Hinsdale.
58	Walsenburg limonite-siderite	Huerfano.
59	Morrison limonite-hematite-siderite	Jefferson.
60	Kennedy gulch magnetite	Do.
61	Leadville limonite-hematite-siderite	Lake.
62	Twin Lake magnetite	Do.
63	Corsky Creek magnetite	Do.
64	Babcock Peak magnetite	La Plata.
65	Larimer County hematites	Larimer.
66	Langford-Trail Creek magnetite	Do.
67	Trinidad limonite-siderite	Las Animas.
68	Paint hematite	Moffat.
69	Iron mine hematite	Do.
70	Zenobia Mountain hematite-limonite-ochre	Do.
71	Indian Trail Ridge magnetite	Montezuma.
72	Rush Basin limonite	Do.
73	Dunmore hematite	Ouray.
74	Guston limonite	Do.
75	Ironton Park limonite	Do.
76	Ouray magnetite	Do.
77	Uncompahgre Park ferruginous tufa	Do.
78	Tarryall Creek magnetite	Park.
79	Handcart Gulch-Hall Valley limonite	Do.
80	Geneva Park magnetite	Do.
81	Cooper Creek magnetites	Pitkin.
82	Coopers Fork magnetite	Do.
83	Avalanche Creek magnetite	Do.
84	Overton-Steele Hollow limonite-siderite	Pueblo.
85	South of Pueblo limonite-siderite	Do.
86	Beulah hematite	Do.
87	Alder limonite	Saguache.
88	Del Norte limonite	Do.
89	Indian Creek limonite	Do.
90	Kerber Creek limonite	Do.
91	Major Creek limonite	Do.
92	Orient mine limonite-hematite	Do.
93	Burro Bridge-Chattanooga limonite	San Juan.
94	Cement Creek limonite	Do.
95	Mineral Creek limonite	Do.
96	Silverton limonite	Do.
97	Iron Springs limonites	San Miguel.
98	Snake River limonite	Summit.
99	Breckenridge magnetite	Do.
100	Rico pyrite-hematite	Dolores.

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IRON MINERALS

Iron oxides are widespread as rock constituents in Colorado and color many of the formations yellow, red, and brown. Low concentrations of the iron oxides are present as small, scattered bodies of ocherous materials, which have some pigmentary properties. In higher concentrations the oxides have value as sources of iron. The principal iron ores are limonite, hematite, and magnetite.

Pyrite (FeS_2), an iron sulfide, also may be considered a possible byproduct source of iron when used under special situations other than as iron ore. When roasted at 1,600° F. it forms a brilliant red hematite and sulfur dioxide gas.

Limonite

Limonite ($Fe_2O_3.nH_2O$) occurs as one of several iron hydroxides or mixtures of them and consequently is subject to considerable variation in chemical and physical properties. It commonly is associated with goethite ($Fe_2O_3 \cdot H_2O$), hematite (Fe_2O_3), and turgite ($2Fe_2O_3 \cdot H_2O$). Limonite is the common oxidation product of iron oxides, iron sulfides, nonferrous ores containing pyrite and marcasite (FeS_2), siderite ($FeCO_3$), and iron-bearing, rock-forming minerals. It forms the oxidized cappings or gossans of many ore deposits, which, where concentrated and extensive enough, are a source of iron. Limonite also occurs as an inorganic or biogenic precipitate in swamps (bogs) and around springs. It occurs as coatings and as the cement of conglomerates and breccias composed of the sand and gravel of creek bottoms and talus; as loose, clinkery, or dense masses mixed with bog or swamp debris; as soft, powdery, earthy, mushy, or claylike masses; and as porous, flocculent, vesicular, ocherous, and solid masses. Its color ranges through yellow, orange, brown, and near-black. Its streak is yellowish brown, and its hardness may vary considerably. Limonite deposits vary widely in purity and may contain manganese and a variety of foreign substances, such as sulfur, phosphorus, lime, and silica. Large bodies of pyrite, pyritic nonferrous minerals, or siderite may become more or less completely oxidized and form deposits classed as iron ores. Limonite is often called brown ore, bog iron, ochre, or brown hematite.

Hematite

Hematite (Fe_2O_3) is red to brownish red, steel gray, metallic, or black and occurs in micaceous, platy, columnar, fibrous, reniform, botryoidal, earthy, or ocherous form, frequently mixed with clay, sand, gravel, talus, or other impurities. It may be granular, porous, compact, concretionary, or oolitic. Its streak is cherry red to reddish or purplish brown. Its specific gravity is 4.8 to 5.3. As a pseudomorph after magnetite, it is known as martite. Hematite is a common weathering or oxidation product of siderite, magnetite, limonite, and other iron-bearing minerals and, where concentrated enough, forms iron-ore deposits. Hematite also is known as specular iron, specularite, red hematite, red ochre, rouge, and micaceous iron. It commonly is associated with turgite, goethite, and limonite.

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Magnetite

Magnetite (Fe_3O_4) is a hard, strongly magnetic, black to brownish-black mineral with a metallic to dull luster. It has a hardness of 5.5 to 6.5 and a specific gravity of about 5. It occurs as an accessory mineral in pegmatites, gneisses, schists, and igneous rocks; as magmatic segregations with apatite, pyroxene, and often titanium; in contact-metamorphic replacement-type deposits, in limestone associated with nearby dioritic intrusions, which may contain titanium, manganese, chalcopyrite, pyrite, hematite, olivene, diopside, and garnet; and in relatively high-temperature sulfide veins. Weathering and oxidation alter it to limonite and hematite.

Siderite

Siderite ($FeCO_3$), the iron carbonate, is widely distributed in bedded sedimentary deposits associated with shale, clay, and coal seams; this implies a biogenic origin in an oxygen-deficient environment. It also occurs as replacements of limestone by iron solutions of igneous origin, in many shades of brown and gray and has a hardness of 3.5 to 4 and a specific gravity of about 3.8. Siderite may be massive, fine grained, compact, or concretionary. It also is known as spathic iron, clay ironstone, kidney ore, and blackband ore.

GENERAL GEOLOGY

Pyrite

Extensive deposits of pyrite (FeS) occur in many parts of the State, including Rico, Leadville, and the Gilman mining districts, as vein-, blanket-, and replacement-type deposits.

Limonite

Limonite has formed in concentrations of economic significance through the near-surface oxidation of replacement bodies of iron-bearing carbonate, which originally was introduced into limestone by ascending solutions. This is exemplified by the deposits at the Orient mine, Saguache County, where limonite with some hematite, siderite, and ochre occurs in the lower Leadville limestone of Mississippian age. The limestone is massive and closely jointed, and ore has been found in it over a vertical range of 1,000 feet.

Limonite and ochre replaces Paleozoic, Ordovician(?) limestone in the Indian Creek basin a few miles east of Sargents, in northwest Saguache County.

Limonite and ochre have been formed by the oxidation of pyrite and other iron-bearing minerals, as shown by the gossans that cap innumerable nonferrous metal deposits in western Colorado.

Limonite also occurs as an inorganic precipitate around springs and in swamps or bogs. Ground water passing over oxidizing pyritic bodies leaches the iron in the form of a sulfate that, on hydrolyzing, forms limonite. The limonite, with some goethite and turgite, is found in fairly pure deposits at the orifices of springs and immediately below them. Examples of this type of

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deposit are at Iron Springs in San Miguel County, at Redwell Basin in Gunnison County, and at other places. Limonite, goethite, and turgite also are found in the swampy basins below the springs and at many other places where they cement the slope washes, ground moraines, river gravels, and such swamp debris as mosses, plants, leaves, and trees. Such deposits are exemplified by those in Handcart and Geneva Gulches in Park County, the headwaters of the Snake River in Summit County, near Delta in Delta County, and in many other places.

Limonite also occurs as concentrations of concretions of oxidized siderite, released by erosion from the weaker enclosing members of the Cretaceous Laramie, Pierre, and Benton formations. Typical examples are found in the Rusty zone of the Pierre formation north of Pueblo, between Overton and Steele Hollow in Pueblo County; as thin bands and concretions in the Laramie formation east of Trinidad, Las Animas County; and in the Benton formation of the Denver Basin, in Jefferson and Boulder Counties.

Hematite

Hematite is widespread as a secondary mineral and usually is associated with limonite and magnetite. With limonite it is a common mineral in the gossan of many veins and replacement-type deposits. It usually is too scant to be valuable as an iron ore; but when it is accompanied by other valuable metals such as gold, silver, and lead, it is useful as a flux in nonferrous-ore smelters.

Hematite also occurs in large or small deposits formed by the complete oxidation of pyrite bodies, as in the Breece Hill iron mine in the Leadville district of Lake County.

Good-grade specularite (hematite) has been reported to occur in a breccia chimney in Precambrian quartzite and San Juan tuff at the Dunmore mine, 3 miles south of Ouray, Ouray County. The hematite is associated with chalcopyrite, aikinite, rhodochrosite, chlorite, and barite.

Small replacement-type bodies of hematite in limestone and sandstone are exemplified in the Paint iron mine in the Douglas Mountain district, Moffat County.

Hematite as martite, the pseudomorph after magnetite, and as secondary hematite occurs with magnetite, apatite, quartz, and feldspar in the Iron Hill stock in Gunnison County. Hematite, with magnetite, occurs in veins and cellular siliceous bodies in marblelike carbonatite. Part of the hematite is of hydrothermal origin; part results from oxidation of pyrite; and part follows leaching and oxidation of iron-bearing carbonate.

Argillaceous hematite (red oxide) also is found as cavern fillings in limestone just west of Manitou Springs, El Paso County.

Magnetite

Magnetite occurs in contact-metamorphic replacement-type deposits, generally in Carboniferous limestones associated with nearby Tertiary diorites

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or monzonites. Deposits of this type are exemplified by the Coopers Fork and like deposits in the Elk Mountains of Pitkin and Gunnison Counties; the Cumberland and Iron King deposits in the vicinity of Pitkin and Whitepine, Gunnison County; the Boss Lake deposit near Monarch, the Calumet-Hecla-Smithville deposit near Salida, Chaffee County; the Star of the West deposits near Russell, Costilla County; and by many others. The magnetites usually occur with some pyrite and chalcopyrite and their oxidation products, a little manganese, and a variety of other minerals, including chlorite, quartz, epidote, garnet, diopside, scapolite, and actinolite.

In the Iron Hill stock 20 miles south of Iola, Gunnison County, magnetite of hydrothermal origin occurs with perovksite ($CaTiO_3$) and some ilmenite ($FeTiO_3$). In places the magnetite has been altered to martite. These minerals are associated with marblelike carbonatite and are abundant primary minerals in pyroxenite and, to a lesser extent, in the other igneous rocks that form the Iron Hill stock.

Magnetite also occurs in deposits formed by magmatic segregations, such as those found at Caribou, in Boulder County. There the deposits consist of titaniferous magnetite, magnetite pyroxenite, and magnetite peridotite with pyroxenite, hornblendite, biotite amphibolite, biotite pyroxenite, and gabbro within the Caribou monzonite and quartz monzonite stock.

Siderite

The iron carbonate, siderite, is not a significant source of iron in Colorado. It received some prominence in the early 1870's and 80's when its oxidation products, limonite and hematite, were used to make iron at Marshall, Trinidad, and Pueblo. It occurs commonly throughout long stretches of parts of the Cretaceous Benton, Pierre, and Laramie formations as thin beds, seams, and concretions too scattered and low grade to be classed as iron ore in our present economy. Typical localities in which the siderite is more or less weathered to limonite are the Rusty zone of the Pierre formation north of Pueblo; between Overton and Steele Hollow, Pueblo County; the Laramie formation near El Moro and Trinidad, in Las Animas County; near Walsenburg, in Huerfano County; and in the Benton formation of the Denver Basin, Jefferson and Boulder Counties.

Light-gray to brownish manganiferous siderite is abundant as a gangue mineral and is reported to form extensive envelopes around replacement bodies of nonferrous metals in the Mississippian Leadville limestone of the Red Cliff-Battle Mountain district of Eagle County.

Manganiferous siderite also occurs in replacement-type deposits of nonferrous metals in the Leadville limestone in the Leadville district of Lake County.

MINING OPERATIONS

Nearly all the known iron occurrences in Colorado have been prospected at some time or another. Prospecting generally was limited to digging a few

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shallow pits, trenches, or cuts. The greatest activity in iron mining was during 1872-1931. Iron ores were produced more or less selectively. Only the better grade ores were mined, and beneficiation was by hand sorting at the mines. The ores then were hauled to a railroad and shipped chiefly to Pueblo to be smelted by the Colorado Fuel and Iron Corp. Mining usually was begun in opencuts, followed by underground mining in which adits and inclines were driven on or to the ore. The ore was removed by room-and-pillar methods similar to those used in coal mining or by open-stope methods or by some form of stull or square-set stoping. Many of the mines are now inaccessible. Since 1931 iron ore has been produced sporadically at a few small opencut operations for special uses other than smelting.

IRON OCCURRENCES BY COUNTIES

Boulder County

Caribou Titaniferous Magnetite

Titaniferous magnetite occurs in Caribou Hill near the old mining town of Caribou, in secs. 5 and 8, T. 1 S., R. 73 W., sixth principal meridian, at about 10,000 feet altitude (fig. 1, location 1). The deposits are in the Grand Island (Caribou) mining district, about 18 miles west-southwest of Boulder and 55 miles northwest of Denver by road. The deposits are readily accessible over good roads.

Titaniferous (ilmenite) magnetite, reportedly of magmatic origin, occurs as individual grains, blebs, small lenses, stringers, and veinlets up to about 8 inches thick. They form enriched mafic rock masses composed of magnetite pyroxenite, magnetite peridotite, biotite pyroxenite, biotite amphibolite, gabbro, pyroxenite, and hornblendite within the Caribou monzonite and quartz monzonite stock. Eight such masses were identified by their outcrops or by magnetic anomalies. They have an aggregate area of 16 acres, and their iron and titanium content differs widely. Their approximate surface dimensions are shown in table 3.

TABLE 3. - Horizontal extent of eight Caribou Hill titaniferous magnetite deposits (feet)

	Length	Width		Length	Width
1.....	1,200	500	5.....	200	150
2.....	550	400	6.....	200	100
3.....	500	250	7.....	150	100
4.....	400	200	8.....	150	50

Chemical analyses obtained from various sources show that the rock contains 36 to 59.4 percent iron and 2.5 to 36.0 percent titanium. A sample of the better magnetite analyzed by the Bureau of Mines contained 52.5 percent iron, 0.01 percent phosphorus, 0.15 percent sulfur, 9.0 percent silica, 0.8 percent manganese, and 3.5 percent titanium. A sample of medium-grade ore is reported by Jennings to contain 67.25 percent magnetite, 8.50 percent ilmenite, 0.18 percent apatite, 6.7 percent spinel, 16.89 percent diopside, and

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0.51 percent water. A small quantity of ore was produced from two small cuts and used as flux in the old Boyd smelter at Boulder.

The composite magnetite area has been partly investigated by geophysical means, and evidence as to its size is inconclusive. The magnetite is believed to extend to substantial depth. It has been mapped by Smith (74)3/, Bastin (4), and Lovering and Goddard (58). The masses appear small and with their titanium content are not acceptable as iron ore. They may be used for special purposes in the future.

References: (4, pp. 129-130; 12, pp. 266-273; 45, pp. 1-45; 51, pp. 14-25; 58, pp. 197-198; 71, pp. 125-128; 74, pp. 8-26).

Miscellaneous Siderite-Limonite-Hematite

Siderite, limonite, and hematite concretions occur over a wide area, from South Boulder Creek to Coal Creek, in T. 1 S., R. 70 W., sixth principal meridian, near the town of Marshall. The general area in which they were found is shown as location 4 on figure 1.

The siderite is dispersed within thin beds, up to 3 feet thick, near and usually over, the coalbeds in the Cretaceous Laramie formations. The coalbeds in this area, called the Boulder coalfield, are in the Davidson and the Coal Creek synclines. The Davidson syncline trends across Davidson and Lake Mesas; its axis is 1 mile east of Marshall. The Coal Creek syncline underlies the valley of Coal Creek. The siderite, weathered to limonite, is exposed along the banks of Rock Creek and Coal Creek. Concretions, nodules, and boulders of siderite weather out of the formation and are altered to limonite and hematite. They range in size from sand grains to boulders weighing more than 1,000 pounds and containing up to 60 percent iron. A sample taken from an old stockpile in 1880 contained 47.89 percent natural iron and 0.305 percent phosphorus. The nodules are too scattered, and in general too low grade, to be considered a significant source of iron ore.

References: (8, pp. 13-24; 12, pp. 266-273; 36, p. 339; 66, p. 538).

Miscellaneous Hematite and Magnetite

Hematite is disseminated in quartz and in veinlets up to several inches thick that form a stockwork within breccia reefs in the Boulder district. The hematite is in small deposits. Most of it is siliceous, but some is nearly pure. Examples of such occurrences are reported at the Clark Tunnel and Barker No. 2 mines in the Hurricane Hill breccia reef at Tungsten Post Office in T. 1 S., R. 72 W. The Hurricane Hill breccia reef is 20 to 30 feet wide and dips 55° NE. Other small occurrences of hematite are reported at the Greyback and Illinois mines, along Beaver Creek, and at the west end of the Black Hawk No. 1 vein in T. 1 S., R. 73 W.

3/ Underlined number in parentheses refers to items in the bibliography at the end of this report. Page references refer to pages in the items and not in this report.

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Magnetite was noted at the Red Signe and Eagle Rock mines in T. 1 N., R. 71 W., (approx. location 3, fig. 1). Magnetite and ilmenite comprise 5 to 10 percent of the Iron Dike gabbro. The dike trends northwesterly through Black Tiger Gulch and Sugar Loaf; it is 20 to 50 feet wide and has been traced for more than 25 miles.

Titaniferous magnetite is an accessory mineral in green hornblendite on Bald Mountain in the vicinity of the Bald Mountain tunnel, 1 mile northwest of Caribou. It also is found in an arcuate, gabbro mass, half a mile long and 400 feet wide, on the north side of Beaver Creek in sec. 14, T. 1 S., R. 73 W., (location 2, fig. 1).

Reference: (4).

Chaffee County

Boss Lake Magnetite

Magnetite occurs as an irregular, replacement-type deposit along the east shore of Boss Lake (fig. 2) at an altitude of about 11,000 feet. The deposit is on the Boss 1 and 2 and Boss Fraction patented claims on Syncline Hill in secs. 28 and 29, T. 50 N., R. 6 E., New Mexico principal meridian (location 5, fig. 1). Magnetite outcrops along the east side of Boss Lake. It is exposed over widths of 2 to 10 feet and for a length of about 300 feet in bluish-gray limestone of Pennsylvania-Permian(?) age, in undifferentiated Belden shale-Minturn formations and in Devonian Ouray limestone, associated with Tertiary intrusives. The strike and dip of the limestone are variable.

The deposit has been prospected with three small cuts and an adit, which is caved. A sample of the magnetite assayed 64.2 percent iron, 0.01 percent phosphorus, 0.07 percent sulfur, 2.0 percent silica, and 0.3 percent manganese. nese

A spectrographic analysis of the sample indicates that it contains 0.001-0.01 percent copper, lead, gallium, indium, beryllium, and zirconium, 0.01-0.1 percent titanium, and 0.1-1.0 percent manganese.

No ore has been produced from the property.

References: (19, pp. 12, 34, Pl. 2; 33, p. 46).

Calumet-Hecla-Smithville Magnetite

This deposit was discovered about 1880 and was mined continuously by the Colorado Coal and Iron Co. from 1882 through 1899. The total production was 239,363 long tons of magnetite iron ore. The deposit is in secs. 26, 27, 34, and 35, T. 51 N., R. 9 E., New Mexico principal meridian, Turret Creek mining district, at an altitude of 9,500 feet (location 6, fig. 1). The deposit is covered by the Calumet, Calumet No. 2, Hecla, Hecla No. 2, Smithville, and Smithville No. 2 patented lode claims comprising 62 acres, and by the Calumet, Hecla-Williamson, and Smithville patented placer claims. The claims are 11.7 miles northeasterly from Salida, up the Ute Trail and Railroad

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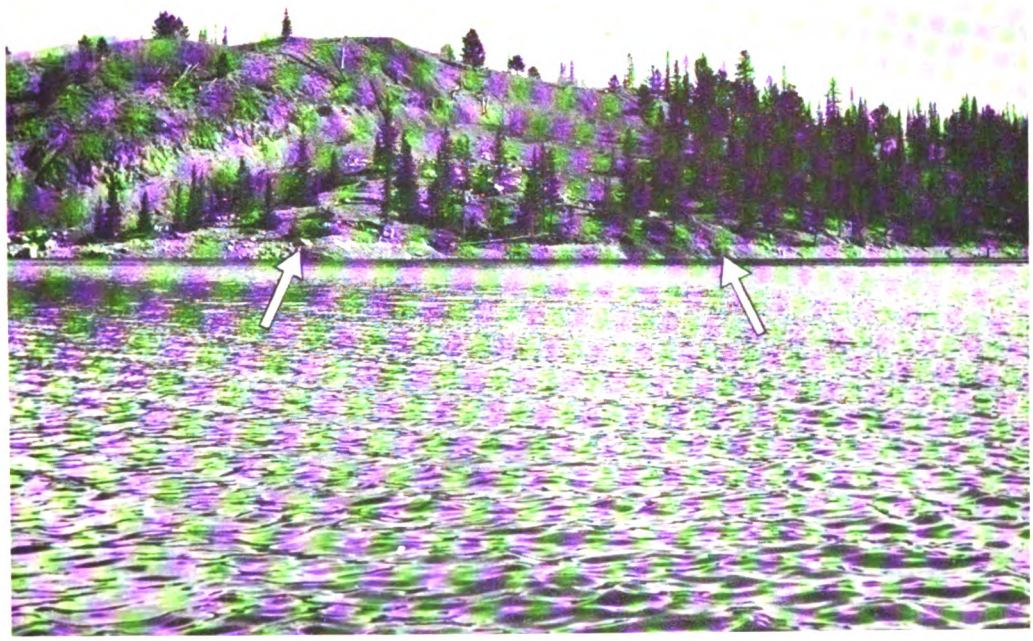

FIGURE 2. - Boss Lake Magnetite Deposit, Chaffee County, Colo. Magnetite and old workings just above water level, between arrows.

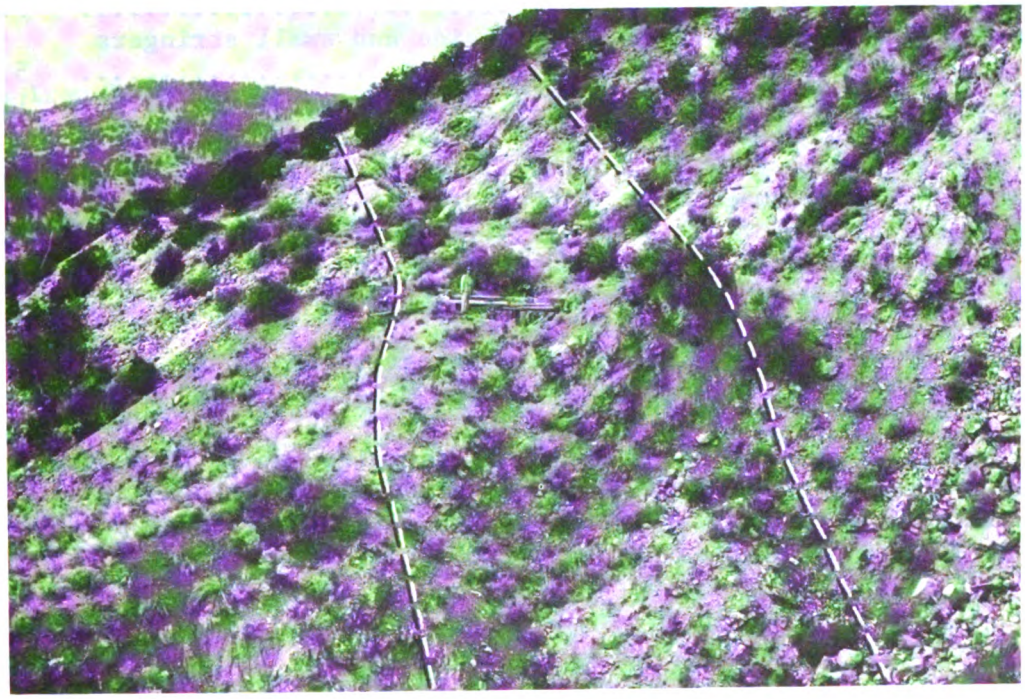

FIGURE 3. - Calumet-Hecla-Smithville Magnetite, Chaffee County, Colo. Opencuts and old shaft along strike; width of deposit as shown in outlined section.

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Gulch. Surface rights belong to George E. Everett and mineral rights to the Calcium Co., both of Salida. The mine is extensively developed underground by shafts, inclines, and adits, but all the workings, except two opencuts, are inaccessible (fig. 3). Early-day mining was done by square-set stoping, which was changed later to the less selective system of open-stope mining. During the 1890's an unsuccessful attempt was made to free the ore of sulfur by roasting. Exploration in 1905 indicated that the remaining ore was high in sulfur.

Magnetite, with some hematite, limonite, pyrite, chalcopyrite, azurite, and malachite, occurs as a contact-metamorphic, replacement-type deposit on or near the contact between white to gray Mississippian limestone and Tertiary intrusives. The gangue minerals include calcite, diopside, epidote, garnet, biotite, apatite, tremolite, and actinolite. The magnetite replaces a definite series of beds in the limestone. The ore body is reported to be 40 to 50 feet thick and about 500 feet wide and has been traced about 1,800 feet downdip. The magnetite occurs mainly as bands parallel to the bedding, a fraction of an inch to 2 feet thick and separated by light-green silicated limestone. A section of the ore body exposed in a large opencut (fig. 3) was measured as follows:

TABLE 4. - Measured section Calumet-Hecla-Smithville magnetite ore body (feet)

Hanging wall, dip 38°-45° - bleached and siliceous limestone.	
Brown layer of silicates and garnet.....	2.5
Brown massive beds with layers of magnetite up to 2 inches thick.....	7.5
Altered greenish limestone with diopside and small stringers of magnetite.....	5.0
Solid magnetite.....	1.0
Barren layer of silicates.....	.5
Solid magnetite.....	1.0
Layered or banded magnetite, epidote, and diopside.....	4.5
Solid magnetite.....	2.0
Foot wall - bleached and siliceous limestone.	
Total thickness of exposed magnetite deposit.....	24.0

The enclosing limestone trends northeasterly through section 35 and northwesterly through sections 26 and 27 and dips 40° to 60° northwesterly.

The ore first mined was very pure and contained up to 60 percent iron. As mining proceeded, the grade of the ore gradually decreased, and the sulfur (pyrite) content increased. The ore last mined contained 43 percent iron. The following analyses were obtained from various sources:

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TABLE 5. - Chemical analyses of ore from Calumet-Hecla-Smithville magnetite

Fe	SiO_2	S	P	Mn	Al_2O_3	CaO	Mn	Remarks
60.9	10.6	0.63	-	-	-	-	-	Typical ore shipped in 1887.
43.7	19.0	.52	0.017	-	-	-	-	Typical ore shipped in 1894.
55.7	14.6	.03	.01	0.2	-	-	-	Ti by spectrograph. 0.01-0.1. Sample by Bureau of Mines, 1957.
49.26	-	-	.026	-	-	-	-	Sample 86 feet below surface in incline.
48.03	-	-	.008	-	-	-	-	Prospect hole on Hecla claim.
63.28	7.04	.61	.007	-	1.9	1.59	1.70	Calumet mine ore at 300 feet depth.
51.3	12.4	1.42	-	-	-	-	-	Raw ore.

A spectrographic analysis of an ore sample by the Bureau of Mines indicates 0.01-0.1 percent titanium and nickel, 0.001-0.01 percent copper, lead, gallium, zirconium, vanadium, chromium, and cobalt, and 0.1-1.0 percent manganese.

Underground workings are inaccessible. Any ore left probably will require beneficiation to make a high-iron, low-sulphur product.

References: (3, pp. 94, 569-572; 5, pp. 781-804; 8, pp. 13-24; 11, pp. 123-124; 12, pp. 266-273; 63, 42 pp.; 66, pp. 472-485; 68, pp. 266-273; 77, pp. 144-145).

Iron King (Hawkins) Hematite

The Iron King hematite deposit is in the NW1/4 sec. 2, T. 50 N., R. 9 E., New Mexico principal meridian, a few hundred feet uphill from the Turret road, in the Turret Creek mining district, and about 1 mile south of the Calumet magnetite mine (location 7, fig. 1). It formerly was known as the Hawkins Hematite Bank and the Iron King gold mine.

There is no record of any production. The ore was reported as mined for gold and silver until the 1920's.

Red hematite occurs as a small, irregular body along a fault zone in altered limestone. Assays of the ore are shown in table 6.

TABLE 6. - Chemical analyses of Iron King hematite

Fe	P	S	SiO_2	Mn	Remarks
49.3	0.27	0.06	22.2	-	Sample of best hematite (8).
30.2	.13	.39	40.8	0.2	Bureau of Mines sample, 1958; characteristic of remaining ore.

A spectrographic analysis indicates the presence of 0.1-1 percent titanium, 0.01-0.1 percent copper, lead, vanadium, cobalt, nickel, and manganese, and 0.001-0.01 percent gallium, zirconium, and chromium.

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Some of the ore probably was used as nonferrous smelter flux.

Workings consist of an almost circular open pit about 50 feet in depth and 60 feet in diameter. A short adit connects with the pit about 25 feet below the surface. The deposit appears to be small.

References: (63, pp. 2, 35, 38, 40; 8).

Mineral Basin Magnetite

Magnetite occurs also in Mineral Basin (location 9, fig. 1) at the head of Cottonwood Creek in the Tincup mining district, near the corner common to secs. 1 and 12, T. 15 S., R. 81 W., and secs. 6 and 7, T. 15 S., R. 80 W., New Mexico principal meridian. Access to the property is difficult up Cottonwood Creek from Buena Vista.

Magnetite occurs as a contact-metamorphic, replacement-type deposit in Carboniferous limestone, associated with a Tertiary(?) intrusive. The deposit was developed by two shafts and workings now inaccessible. At one shaft the magnetite appears 5 to 7 feet thick; at the other, it is 10 to 15 feet thick and traceable for about 250 feet. Exposures are poor. Four samples were assayed and found to contain 56.8-63.6 percent iron, 0.6-1.5 percent manganese, 0.01 percent phosphorus, 0.2-21.4 percent sulfur, no titanium, a trace of copper, and 1.3-4.4 percent insoluble residue.

Reference: (43, p. 115).

Miscellaneous Iron Occurrences

A small deposit known as the Bald Hill magnetite was found in the Turret mining district, on Bald Hill, in T. 50 N., R. 9-10 E., New Mexico principal meridian (location 8, fig. 1).

The magnetite occurs as a small replacement-type, contact-metamorphic deposit in a gray limestone bed in the Pennsylvanian Weber formation. The deposit has been worked to some extent.

Reference: (63, p. 12).

Magnetite also occurs 1 mile east of Tenderfoot Hill and about the same distance northeast of Salida, in approximate sec. 34, T. 50 N., R. 9 E., New Mexico principal meridian (location 10, fig. 1). The deposit crops out in the bottom of a steep-walled part of Cottonwood Creek Canyon and is exposed 8 to 10 feet thick over a length of 50 feet. The exposure is poor, and the magnetite is more or less disseminated in Precambrian gneiss.

Limonite is a common accessory mineral in the Garfield-Monarch district. It occurs as gangue in many oxidized lead-zinc-copper deposits, such as the Lilly and Madonna mines in Tps. 49-50 N., R. 6 E., New Mexico principal meridian (locations 11 and 12, fig. 1). The deposits are inaccessible, and little is known of them; they are replacements in the Ordovician calcareous rocks and are not considered an important source of iron.

References: (19, 20, 33).

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Clear Creek County

West Geneva Creek Limonite

The West Geneva iron deposit (fig. 4) is a quarter of a mile northeast of Geneva Lake in sec. 32, T. 5 S., R. 75 W., sixth principal meridian, at

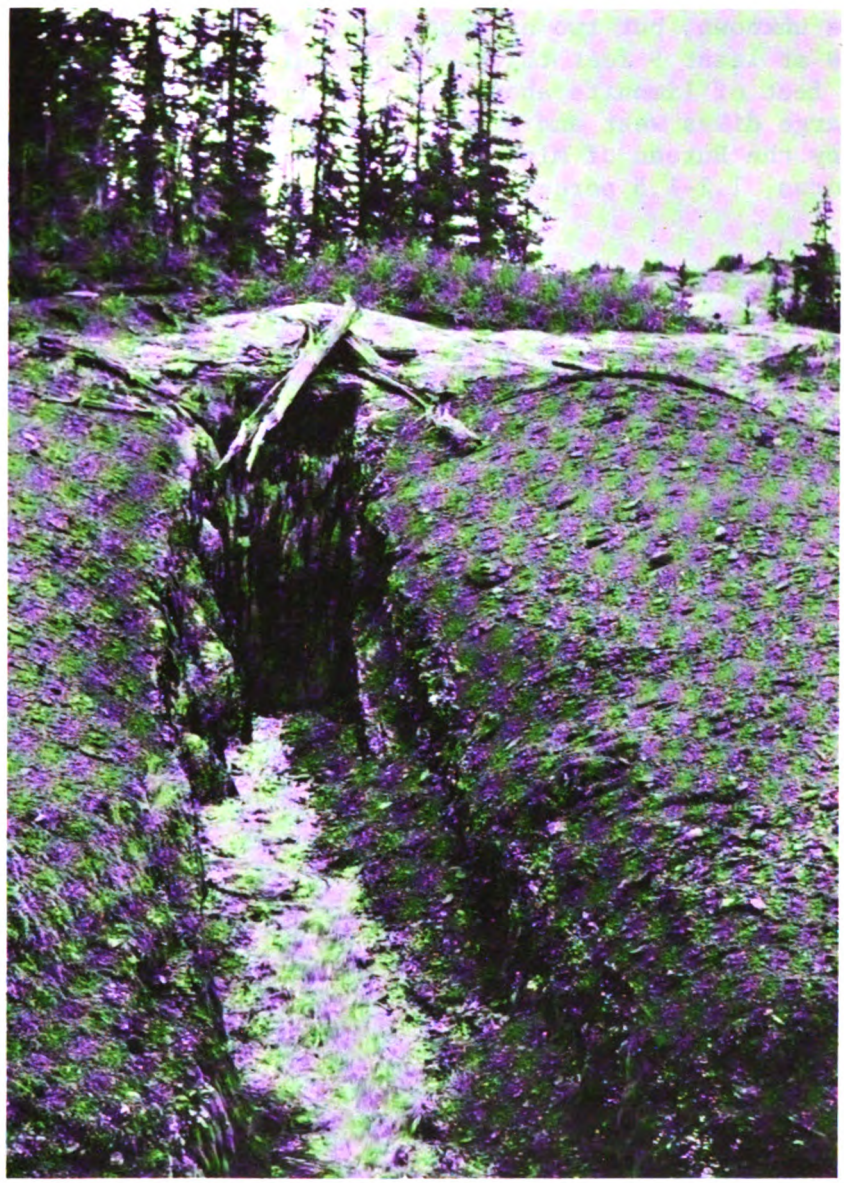

FIGURE 4. - West Geneva Limonite, Clear Creek County, Colo. Limonite being deposited by ground water.

an altitude of about 13,000 feet (location 13, fig. 1). The property is reached by following West Geneva Creek in a northwest direction from Grant, Colo., for 7 miles to the Georgetown road, then turning left at the Georgetown road and continuing up West Geneva Creek 6.2 miles. The last 4 miles

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are over a rough jeep trail. The property is owned by Clear Creek County and is leased to the Stony Point Development Co., Inc., Denver, Colo.

There is no record of production from the property. Limonite and other hydrous iron oxides are being deposited from ferruginous spring waters on the floor of a valley. The surface of the deposit slopes at 10° and is exposed for a length of 800 feet and a minimum width of 250 feet. The thickness of the limonite is unknown, but two opencuts near the center of the deposit show that it is at least 9 feet thick; an old adit near the lower end of the deposit has 15 feet of limonite above it. The iron is derived from sulfides contained in large dikes west and north of the deposit. Three 50-pound samples taken by the Bureau of Mines contained 51-55 percent iron, 0.28-1.9 percent phosphorus, 1.2-1.5 percent sulfur, 0.9-1.1 percent silica, and 0.1 percent lime.

The workings on the property consist of a 30-foot adit and two cuts near the center of the deposit, each 3 feet wide, 9 feet deep, and 25 feet long.

Five limonite deposits of spring and bog origin have been mapped along West Geneva Creek, in secs. 32 and 33, T. 5 S., R. 75 W., sixth principal meridian, between Jackwhacker Gulch and Geneva Lake (location 13, fig. 1). In 1958 the West Geneva deposits were the best exposed. Their approximate dimensions are listed in table 7.

TABLE 7. - Surface dimensions of West Geneva iron limonite deposits

Deposit	Length	Width
1.....	4,200	200
2.....	1,200	300
3.....	1,000	500
4.....	1,000	200
5.....	700	200

The deposits vary in composition, texture, and iron content and are still being formed. They run from dry, well-consolidated, porous-to-hard limonite to loose, unconsolidated, mushy-to-firm mixtures of limonite, bog debris, sand, and gravel.

Reference: (57, p. 54, pl. 3).

Miscellaneous Magnetites

Magnetite is a common constituent of the Precambrian Idaho Springs formation of the Georgetown quadrangle. Quartz-magnetite gneisses within this Precambrian complex are comprised of fine-grained, banded, steel-gray rock containing an abundance of magnetite with quartz, garnet, hornblende, biotite, epidote, chlorite, and zircon. The gneisses are reported to be prominent near the head of Little Bear Creek (approx. T. 4 S., R. 73 W.) and on Trail Creek (approx. T. 3 S., R. 73 W., Clear Creek County, locations 14 and 15, fig. 1). The occurrences are too lean and too small to be a significant source of iron ore.

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Reference: (75, pp. 41-42).

Costilla County

Star of the West Magnetite

The Star of the West magnetite deposit (fig. 5) is in sec. 18, T. 28 S., R. 70 W., and sec. 13, T. 28 S., R. 71 W., in the Grayback mining district (location 16, fig. 1). It is 4 miles N. 11° E. of Russell, on the southwest slope of Grayback Mountain, just east of Grayback Gulch, at altitudes of about 9,500 to 10,400 feet. The deposit is reached by traveling half a mile north from Russell on U.S. Highway No. 160, then turning left

FIGURE 5. - Star of the West Magnetite, Costilla County, Colo. Arrow points to top of 6-foot-thick magnetite zone.

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onto a dirt road and following Placer Creek north for about 2-1/4 miles. At that point, turn right up Grayback Gulch and follow the dirt road north-northeast 2-1/4 miles to the property. It extends from the east side of the road up Grayback Mountain nearly to its top.

The deposit was developed in three mines - The Lower Star of the West, the Star of the West, and the Upper Star of the West. The Lower Star of the West, once called the Stoddard, is owned by Otto Drum of La Veta, Colo. The Star of the West, once called the Ainsworth, and the Upper Star of the West are covered by seven claims owned by Winfield Ripley, Ontario, Calif. These claims are: Homestake, Gilt Edge, Pride of the West, Last Chance, Star of the West, Sunnyside, and Magnolia.

Work in the Star of the West mine began in 1877, when Sefton and Proctor opened the ore body. Between 1,000 and 1,500 tons was mined and shipped to Mather and Geist at Pueblo. The mines were shut down in 1883 after about 20,000 tons had been produced and have been idle since. They reportedly were closed because the sulfide content of the ore had increased and not because of lack of magnetite.

The workings on the property are caved and inaccessible.

The magnetite occurs as replacement-type deposits in Pennsylvanian limestone near Tertiary intrusives. The Lower Star of the West ore body is reported to be 5 feet thick, strikes S. 80° E. and dips 25° S. The magnetite is northeast of, and was cut off by, a fault that strikes S. 40° E. and dips 70° NE. In 1909 a stope 50 feet long and 25 feet wide was observed along this fault; it was caved and inaccessible beyond the 50-foot point.

The Star of the West is 600 feet farther up Grayback Mountain than the Lower Star of the West. The magnetite body is 6 to 10 feet thick, strikes N. 80° E. and dips 35° S. The ore lies south of, and was cut off by, a fault that strikes east and dips 70° S.

The Upper Star of the West is about 150 feet farther up Grayback Mountain than the Star of the West. Its ore body, 1 to 4 feet thick, strikes east and dips 45° S.

Analyses of the ore obtained from various sources are as listed in table 8.

TABLE 8. - Analyses of ore from Star of the West magnetite deposit (percent)

Fe	P	S	SiO_2	Mn	Al_2O_3	CaO	MgO	L.O.I.	Moisture	Remarks
59.23	0.016	-	-	-	-	-	-	-	-	Star of the West.
47.74	.008	-	-	-	-	-	-	-	-	Do.
52.58	.059	-	-	-	-	-	-	-	-	Stockpile from Lower Star of the West.
57.50	.04	-	11.90	-	3.90	0.20	Trace	4.20	-	Star of the West.
56.84	.045	-	8.60	-	81.20	2.20	0.38	4.60	-	Do.
67.30	.007	0.03	3.53	0.11	1.70	.83	.91	-	0	Do.
57.60	.03	.38	8.0	.20						Upper Star of the West; Bureau of Mines sample, 8/14/57.

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A spectrographic analysis of the sample taken by the Bureau of Mines indicates 0.001-0.01 percent silver, gallium, lead, zirconium, and chromium; 0.01-0.1 percent titanium, cobalt, and nickel; and 0.1-1.0 percent manganese.

References: (65, pp. 53-58 and 88-91; 66, pp. 477-480; 68, pp. 266-273; 77, pp. 144-145).

Trinchera Ranch Titaniferous Magnetite

The Trinchera Ranch titaniferous magnetite, known also as the Mineral Ridge or Wagon Creek deposit, is just north of Wagon Creek, in secs. 12-14, T. 29 S., R. 71 W., and secs. 7 and 18, T. 29 S., R. 70 W., sixth principal meridian, about 2 miles southeast of Russell Postoffice (location 17, fig. 1). The deposit is on the Trinchera ranch owned by Albert R. Sims, of Albuquerque, N. Mex., and Blanca, Colo. The deposit was known before 1886 but has yielded no production.

Titaniferous magnetite occurs in a 10,000-foot-long, hook-shaped zone of gabbro, hornblendite, hornblende gneiss, biotite schist, diorite, and pegmatite and is enclosed almost completely in Precambrian granite gneiss. Its northeast end is against limestone. The zone ranges in width from about 3,500 feet at its northeast end to 400 feet at the tip of the hook to the northwest. Titaniferous magnetite occurs within this zone as grains, blebs, and scattered masses through an exposed relief of over 200 feet. Samples of the magnetite assayed as shown in table 9.

TABLE 9. - Analyses of Trinchera Ranch titaniferous magnetite (percent)

Fe	P	S	SiO_2	Mn	TiO_2	Remarks
33.0	0.58	0.27	27.8	0.5	1.0-10.0 (spectrographic)	Character sample by Bureau of Mines, 8/14/57.
34.4	3.3	.1	22.9	-	6.5	Selected sample.

A spectrographic analysis of the magnetite indicated the content shown in table 10.

TABLE 10. - Spectrographic analysis of Trinchera Ranch titaniferous magnetite

Mineral	Content range, percent	Mineral	Content range, percent
Aluminum	1.0 -10.0	Manganese	.1 - 1.0
Barium	.01 - .1	Nickel	.01 - .1
Calcium	1.0 -10.0	Phosphorous	.1 - 1.0
Cobalt	.01 - .1	Scandium	.01 - .1
Copper	.01 - .1	Silicon	>10.0
Chromium	.001- .01	Sodium	.1 - 1.0
Gallium	.001- .01	Titanium	1.0 -10.0
Iron	>10.0	Vanadium	.01 - .1
Lead	.001- .01	Zirconium	.001- .01
Magnesium	>10.0		

References: (34; 68, pp. 266-273).

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Miscellaneous Iron Occurrences

Magnetite was reported in Talmich Gulch approximately in sec. 9, T. 28 S., R. 71 W., sixth principal meridian, in the Russell (Grayback) mining district (location 18, fig. 1). The outcrop is poorly exposed, and approximation of size was impossible.

Reference: Local inquiry.

Custer County

Wahl Mine Manganiferous Limonite

Manganiferous limonite occurs in the Blue Mountains, 2.3 miles north of Westcliffe on the De Weese Reservoir road, in the N1/2 sec. 5, T. 22 S., R. 72 W., sixth principal meridian, Hardscrabble mining district (location 19, fig. 1). The deposit is on the Hudson Bay (survey 207), Iron Contact (287), South Contact (288), Silver Iron (289), Dakota (209), and Boss (206) claims. The property is known as the Wahl mine and Black Pit and is now the property of George D. Schweigert, of Denver, Colo.

Yellow-to-red and bluish-black limonite is exposed along the crest of a low, rounded, northwest-trending ridge in outcrops, an open pit, bulldozer cuts, and shallow shafts. The deposit is traceable over a width of 300 feet and a length of about 1,900 feet. Several cuts and shafts in the deposit indicate a depth of over 12 feet. Limonite recently was exposed for a width of 300 feet (N.-S.) in the new De Weese Reservoir roadbed, 2.3 miles north of its junction with Colorado State Highway No. 69 at the Westcliffe city limits. This exposure is 0.3 mile northwest of the old C. F. & I. Corp. pit and indicates that the deposit extends farther northwesterly under shallow soil cover. Whitman Cross (23) describes the ore as "augite gneiss altered so as to produce a black iron ore." Two character samples taken by the Bureau of Mines in 1958 assayed as shown in table 11.

TABLE 11. - Analyses of Wahl mine limonite (percent)

Fe	P	S	SiO_2	Mn	Remarks
43.4	0.4	0.14	14.6	4.8	Character sample from outcrops, pits, and cuts from the De Weese reservoir road southeasterly to the old C. F. & I. Corp. pit.
42.2	.12	.19	11.6	4.3	Character sample from the old C. F. & I. Corp. pit.

The results of spectrographic analysis of the samples are shown in table 12.

TABLE 12. - Spectrographic analysis of Wahl mine limonite

Element	Percent	Element	Percent	Element	Percent
Copper.....	0.01-0.1	Titanium.....	0.01 -0.1	Gallium.....	0.001-0.01
Lead.....	.01- .1	Zirconium....	.001- .01	Silver.....	.001- .01
Zinc.....	.10-1.0	Chromium.....	.001- .01	Mercury.....	.001- .1

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The Colorado Fuel and Iron Corp. produced about 3,900 tons of iron ore from an open pit on the property during 1924. The ore averaged 39.6 percent iron, 6.62 percent manganese, 0.61 percent phosphorus, and 13.66 percent silica. The iron content ranged from 34 to 47 percent, and the manganese from 2.7 to 9.3 percent. Since 1924, ore containing up to 25 percent manganese has been found northwest of the old workings.

Reference: (23, p. 337).

Delta County

Delta (Iron Cap, Mingen) Limonite

The Delta limonite deposit (fig. 6) is on the Iron Cap claim (survey 202,489) recorded in 1941. The ground was not patented and in 1958 was vacant public domain. The deposit is in the SE1/4 sec. 28, T. 15 S., R. 94 W., sixth principal meridian, at 6,000 feet altitude, 10.5 miles east of Delta and 7.2 miles south of Austin, by road (location 20, fig. 1). The deposit was discovered before 1890, and a considerable tonnage of limonite, reportedly as much as 100,000 tons, was mined from the deposit and used as flux in early-day nonferrous-ore smelters at Salida and Gunnison. About 5,000 tons, assaying 51 percent iron, was reported shipped as iron ore to Pueblo about 40 years ago.

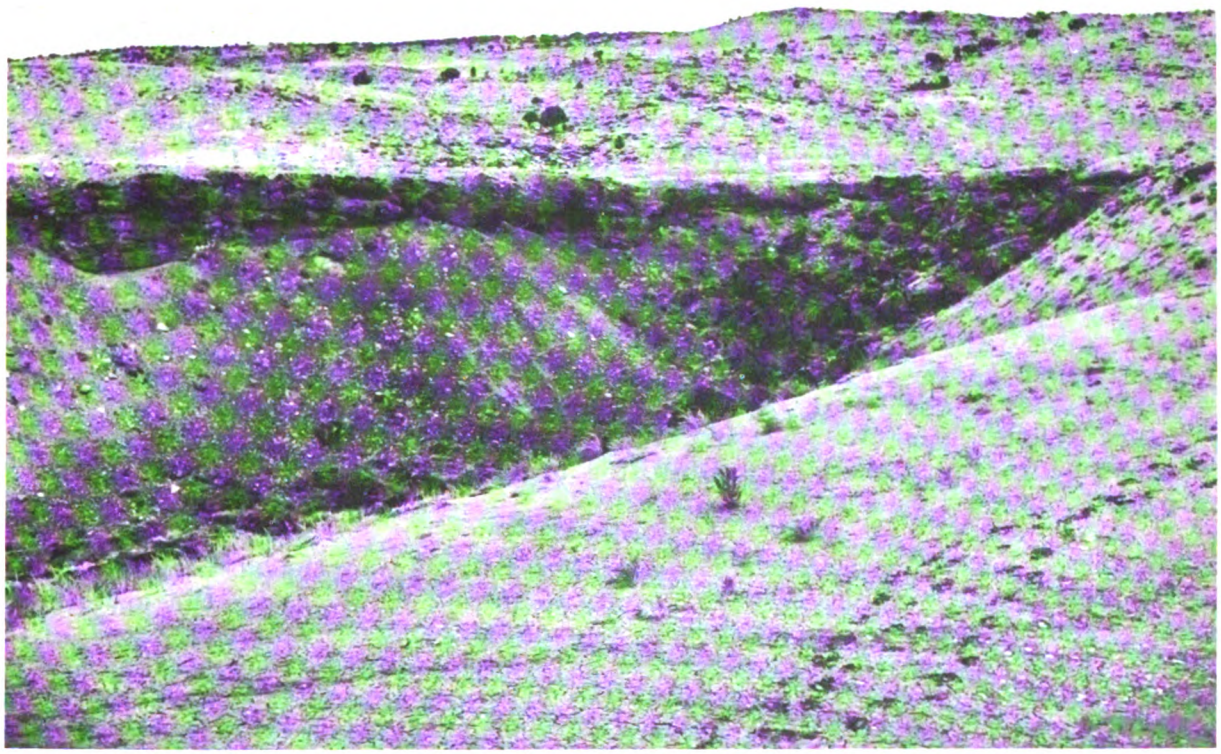

FIGURE 6. - Horizontal Bed of Limonite, Delta Deposit, Delta County, Colo.

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Limonite (brown ore) is exposed over a width of about 250 feet in several east-west gullies and ridges that cross an outcrop 3,000 feet long in the Cretaceous Mancos shale formation. The limonite occurs in thicknesses up to 10 feet and has a variable composition. In places it is nearly pure, porous to clinkery, brown to almost black; in others it appears low grade and ocherous. In parts of the deposit the limonite is a cement binding, coating, and saturating angular and subangular fragments of sandstone and shale. The deposit is covered in part by 2 to 5 feet of loose shale and sandstone and may extend for a considerable distance under the deeper cover to the east, where the land surface slopes abruptly upward. The contents of samples of the deposit are listed in table 13.

TABLE 13. - Analyses of samples from Delta limonite deposit (percent)

Fe	P	S	SiO_2	Mn	Loss on ignition	TiO_2	Remarks
39.7	-	-	28.0	1.5	-	Nil	Sample sent to C. F. & I. Corp. at Pueblo by Mike Mingen of Ouray.
57.2	0.019	-	3.7	.2	-	do.	Do.
49.0	-	-	12.4	-	-	-	25-lb. composite sample by W. P. Huleatt, Bureau of Mines, 5/26/43.
47.5	.03	0.47	13.8	<.01	12.6	-	Character sample by Bureau of Mines, November 1957.

Workings on the property consist of a few short adits, opencuts, and shallow pits.

A spectrographic analysis of the limonite shows a content of 0.001-0.01 percent copper, gallium, scandium, ytterbium, zirconium, and lead; 0.01-0.1 percent manganese, nickel, and titanium; and 0.1-1.0 percent zinc.

Dolores County

Rico Spring and Bog Limonite

Ferruginous springs occur in several places in the Rico Mountains and are the source of deposits of limonite that have cemented surface and bog debris into an iron cap (location 21, fig. 1). The deposits are most numerous near Rico, in the Pioneer (Rico) mining district. There is no recrod of any production from them.

Spring and bog limonite occurs along Silver Creek, northeast of Rico, above the Fort Wayne tunnel, in sec. 25, T. 40 N., R. 11 W; along the upper reaches of the northern and western branches of Horse Creek Gulch in secs. 21 and 28, T. 40 N., R. 11 W., New Mexico principal meridian; and in the lower part of Horse Gulch at the base of the northern landslide area (location 18, fig. 1). Surface waters passing through oxidizing pyrite and other iron-bearing sulfides take the iron in solution. The ferruginous waters issue from the slopes as springs, and their iron content is precipitated as limonite along swampy parts of stream channels.

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The deposits are not developed.

Reference: (29, p. 164).

Miscellaneous Iron Occurrences

Small amounts of magnetite were produced for smelter flux from the Magnet prospect (location 25, fig. 1), at 10,750 feet altitude, on the north side of Darling Ridge, 1-1/2 miles northwest of Rico, and from the Eagle prospect (location 24, fig. 1), at 10,900 feet altitude, between the upper forks of Sulphur Creek, 1-1/2 mile west of Rico. The massive magnetite with a little chalcopyrite replaces limestone.

Reference: (28, p. 15).

A borehole on the Atlantic Cable claim (location 26, fig. 1) penetrated 18 feet of specular hematite overlain by marble, lead-zinc ore, and limestone.

References: (29, p. 42; 43, p. 111).

Masses of limonitic material formed by the oxidation of shattered, pyritic, blanket-type deposits occur on C. H. C. Hill, sec. 24, T. 40 N., R. 11 W., 1-1/4 mile north of Rico (location 22, fig. 1).

References: (28, p. 15; 43).

Soft, black, earthy material, largely hydrous oxides of iron (limonite), and manganese occur on Nigger Baby Hill, in sec. 25, T. 40 N., R. 11 W., half a mile northeast of Rico (location 23, fig. 1).

References: (28, p. 15; 43).

Rico Pyrite-Hematite

Extensive pyrite deposits, containing millions of tons, occur near Rico (location 100, fig. 1) and are being utilized by the Rico Argentine Mining Co., in the production of sulfuric acid. The tailings resulting from the roasted pyrite are a brilliant red hematite, which may be used as a source of iron when a large tonnage has been accumulated. It also may have uses for purposes other than smelter iron.

Eagle County

Miscellaneous Iron Occurrences

In the Pando area, 3 miles southeast of Red Cliff (location 27, fig. 1), hard brown limonite occurs in a limy zone 50 feet above the base of the Cambrian Sawatch quartzite. Many small tunnels and prospect holes along the tops of the cliffs of Sawatch quartzite west of the Eagle River are marked by dumps and stockpiles of hard, brown, iron oxide. The deposits are very small and the product of oxidation of small pyritic bodies. They are unimportant as a source of iron.

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Reference: (78).

Large bodies of low-grade manganiferous iron have been reported in the Red Cliff (Battle Mountain, Gilman) mining district at the old Iron Mask mine, now known as the Eagle Nos. 1 and 2. The deposits crop out on the canyon wall 400-500 feet above the streambed, 2-1/2 miles below Red Cliff (location 28, fig. 1). They belong to the New Jersey Zinc Co. Two deposits that dip 10° to 15° northeasterly occur at nearly the same horizon as lenses along the bedding of Carboniferous limestone. The deposits are about half a mile apart. They are in synclines transverse to the regional strike of the sediments. Manganiferous siderite occurs with iron and zinc sulfides and oxidized material consisting largely of clinkery iron and manganese oxides, iron sulfates, and ocher. Analyses of character samples reported by various authorities are given in table 14.

TABLE 14. - Analyses of ore from Red Cliff limonite-siderite deposits (percent)

Fe	P	S	SiO_2	Mn	MgO	CaO	CO_2	Insol.
37.60	0.023	0.961	3.04	18.60	-	-	-	-
38.0	low	-	1-2	12-15	-	-	-	-
27.77	-	.35	-	8.75	10.56	0.87	40.10	0.26
19.49	-	.18	-	9.52	16.13	1.75	42.50	.17

The main deposits were explored extensively for sphalerite and pyrite, one for about 2,000 feet and another for 3,000 feet downdip. The zinc and iron sulfides occur in a manganiferous siderite gangue. Yellow-to-brown manganiferous limonite and light gray-to-brownish siderite (manganosiderite) occur as disseminated gangue and as envelopes around the replacement deposits of zinc ore in Mississippian Leadville limestone and in places extend into them.

Umpleby (1917) estimated unclassified reserves of 750,000 tons of ore averaging 38 percent iron, 12-15 percent manganese, 1-2 percent silica, and low phosphorus.

Muilenburg (1919) estimated about 1 million tons of manganiferous iron ore and lists a character sample as containing 37.6 percent iron, 18.6 percent manganese, 3.04 percent silica, 0.023 percent phosphorus, and 0.961 percent sulfur.

About 200,000 tons from these deposits was used as metallurgical flux in nonferrous smelters.

References: (21, pp. 48-49; 59, pp. 36-37; 79, pp. 1140-1141).

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El Paso County

Miscellaneous Iron Occurrences

A small amount of red hematite-goethite was mined near Childs limestone quarry on Fountain Creek, approximately in sec. 32, T. 12 S., R. 68 W., sixth principal meridian (location 29, fig. 1).

A small amount of yellow ochre was mined from a deposit in Talca Gulch approximately in sec. 10, T. 13 S., R. 68 W., sixth principal meridian (location 30, fig. 1). Forty tons of hematite and 20 tons of the yellow ochre were used as paint pigments by the Colorado Midland Railroad Co.

Argillaceous hematite-goethite occurs as cavern filling just west of Manitou Springs, where the limestone is bent and shattered (location 31, fig. 1).

Fountain Creek Magnetite

Magnetite occurs in Precambrian schist near the headwaters of Fountain Creek, in sec. 10, T. 16 S., R. 67 W., sixth principal meridian (location 32, fig. 1). The deposit is on the Ruby Helen claims about 10 miles west of Fountain and is accessible over a jeep road. The deposit appears small. Five carloads of ore shipped averaged about 43 percent iron and 2 percent titanium, according to information furnished by John Schroyer, 209 Mining Exchange Building, Colorado Springs, Colo.

Reference: (70, p. 235).

Fremont County

Iron Mountain Titaniferous Magnetite

The Iron Mountain titaniferous magnetite deposit is in secs. 2, 3, 4, 9, and 10, T. 20 S., R. 72 W., sixth principal meridian, about 12 miles southwest of Canon City and 15 miles north-northeast of Westcliffe (location 33, fig. 1). The deposit is reached by driving 5-1/2 miles south from Texas Creek on Colorado State Highway No. 69 to the mouth of Road Gulch, then easterly along a graded road for 7 miles to a ranch road, which is followed 3-1/2 miles southeasterly to the deposit. The deposit also can be reached from Parkdale by driving 11-1/2 miles southwesterly up Copper Gulch to the same ranch road and then 3-1/2 miles southeasterly.

The Iron Mountain claims were patented in 1872. Before 1880 ownership passed to predecessors of the Colorado Fuel and Iron Corp. In 1945 ownership passed to A. C. and H. L. Ellison, of Hillsdale, Colo., but the claims now are the property of the Ellison estate and family. The property was under lease to A. Poston, of Canon City, in 1957.

Incomplete information indicates a production between 1872 and 1956 of about 1,000 tons of ore used in making iron and as nonferrous smelter flux.

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During 1955-56 about 35,000 tons of magnetite with a specific gravity of 4.25 was mined and processed to plus-1/4-inch size for use as heavy aggregate in submarine concrete emplacements and pipeline coatings.

The property was investigated by the Bureau of Mines in 1912 and later in 1948-49 and 1957-58.

Granites and gneisses in the area are cut by numerous dikes of pyroxenite and a large mass of gabbro. The greater part of this gabbro mass forms Iron Mountain and continues southward across a low, flat spur of Iron Mountain and two small hills separated by dry arroyos. The titaniferous magnetite deposits are in this flat spur and two small hills and trend north.

The first hill south of the spur of Iron Mountain has the best exposures of magnetite and is the site of past opencut mining. This hill extends 800 feet in a northerly direction and is about 500 feet wide and 60 feet high. Magnetite is exposed in widths up to 50 feet. Little is known of the size or character of the deposit. Wall rocks are reported to be anorthosite and gabbro. The ore is a black compact aggregate of magnetite and ilmenite with some spinel, feldspar, olivene, biotite, hornblende, augite, and quartz. The titanium mineral ilmenite is intergrown with the magnetite. About one third of the ilmenite is reported to be in grains large enough to be released when the ore is crushed to 100-mesh.

Analyses of the ore reported by various sources are shown in table 15.

Because of its high titanium content and refractory nature, the rock has little value as an ore of iron. Its future value will be as a possible source of titanium in conjunction with iron, and its use for special purposes such as heavy concrete aggregate, roofing granules, etc.

Mine workings are shallow and comprise several pits, opencuts, and a shaft. Exploration is inadequate for evaluating and estimating reserves.

References: (3, pp. 569-572; 10, p. 16; 12, p. 270; 13, pp. 281-285; 43, p. 114; 66, pp. 472-485, and 538-539; 68, pp. 267-273; 71, pp. 128-134; 77, pp. 144-145).

Miscellaneous Iron Occurrences

Across the river from Cotopaxi (location 37, fig. 1) a 600-foot tunnel reportedly was driven in 1883 to develop magnetite, containing approximately 59 percent iron and 7 percent silica, in Precambrian rocks. The occurrence is in approximate secs. 30-31, T. 48 N., R. 12 E., New Mexico principal meridian. Cotopaxi is 26 miles west of Canon City.

Reference: (58, p. 67).

Small veins of hematite in granite are reported north of Cotopaxi (approximate location 36, fig. 1). The largest vein is reported to be 3-1/2 feet wide and 80 feet long.

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TABLE 15. - Analyses of Iron Mountain titaniferous magnetite (percent)

Sample No.	Fe	TiO_2	P	S	SiO_2	Mn	V_2O_5	Description
1	49.0	14.0	-	-	-	-	0.45	Bureau of Mines sample (1948). Representative of 8 pits in ore, north hill.
2	47.9	13.5	-	-	-	-	.41	Bureau of Mines sample (1948). Representative of ore outcrops farthest south of deposits.
3	48.6	13.7	-	-	-	-	.43	Bureau of Mines sample (1948). Ore exposure north slope of south hill.
4	50.7	14.1	-	-	-	-	.43	Bureau of Mines sample (1948). Ore exposure 300 feet west of sample 3.
5	49.4	13.9	-	-	-	-	.43	Bureau of Mines sample (1948). Representative of ore outcrops farthest north of deposits.
6	12.9	3.2	-	-	-	-	.10	Bureau of Mines sample (1948). Titaniferous augite from hill west of deposits.
7	23.6	13.4	-	-	-	-	-	Bureau of Mines sample (1957). Specimen of better grade ore in open pit.
8	48.89	11.99	0.025	-	-	-	-	Magnetite from southwest part of hill.
9	48.18	12.92	.026	-	-	-	-	Magnetite from south end of hill.
10	46.61	11.61	.037	-	-	-	-	Do.
11	48.85	12.73	.011	-	-	-	-	Magnetite near shaft.
12	46.05	13.84	.040	-	-	-	-	Magnetite near top of hill.
13	47.01	14.86	.039	-	-	-	-	Do.
14	47.42	13.04	.026	-	-	-	-	Do.
15	43.4	10.0	-	-	18.6	-	-	Oxidized iron sand forming several miles of bed of Iron Creek above Iron Mountain.

Hematite is reported in Iron Dollar Gulch, south of Cotopaxi in approximate secs. 7-18, T. 47 N., R. 12 E. The deposit is poorly exposed and too small to be commercial.

Reference: (43, p. 109).

Hematite occurs in the E1/2 sec. 7, T. 49 N., R. 12 E., New Mexico principal meridian, Red Gulch mining district, 12 road miles north of Cotopaxi Post Office and on the northeast slope of Long Gulch (approximate location 36, fig. 1). The property is known variously as the Iron Mine and the Iron Age and Long Gulch lode claims. It is 2,100 feet northeast of the SE cor. sec. 7. Bluish-black hematite occurs along a north-trending shear zone in Precambrian gneiss. The hematite is traceable, in an opencut and by outcrops,

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as a zone about 25 feet wide and approximately 100 feet long, dipping 60° E. The hematite occurs as the nearly pure blue-black mineral and as very siliceous varieties and is exposed over a topographic relief of more than 50 feet. The hematite is partly silicified. A sample taken by the Bureau of Mines during 1958 assayed 46.2 percent iron, 0.2 percent manganese, 0.04 percent phosphorus, 0.11 percent sulfur, and 24.6 percent silica. A spectrographic analysis of the ore indicates the presence of copper, silver, gallium, zirconium, titanium, lead, vanadium chromium, cobalt, and nickel.

A trial shipment to the Colorado Fuel and Iron Corp. at Pueblo proved too siliceous for use as iron ore.

A deposit of magnetite and hematite is reported on Badger Creek in approximate Tps. 50-51 N., R. 10 E., Badger Creek mining district (approximate location 34, fig. 1).

Reference: (43, p. 109).

Canon City Limonite-Siderite

A thin bed of clayey, concretionary limonite-siderite occurs about 12 feet above the Tertiary Canon City coalbed, 6 miles below Canon City, on the Arkansas River (location 35, fig. 1). It is reported to contain 54 percent iron.

Reference: (16, pp. 293-298).

Garfield County

Glenwood Springs Limonite

A small deposit of hard limonite is reported on the hillside back of the Hotel Colorado at Glenwood Springs (location 38, fig. 1).

Reference: (43, pp. 109-116).

Gilpin County

Miscellaneous Iron Occurrences

Titaniferous magnetite occurs as an accessory mineral in a gabbroic rock mass about 500 feet in diameter in the SE1/4 sec. 26, T. 2 S., R. 73 W., (location 39, fig. 1). The magnetite is on the east bank of Missouri Creek, about 1 mile north of Missouri Lake. It is too small and too low grade to be considered a commercial source of iron ore.

Reference: (4, pl. 1).

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Gunnison County

Cebolla Creek Titaniferous Iron Occurrences

The Cebolla Creek (Iron Hill, Powderhorn, etc.) iron occurrences are in the White Earth mining district, east of the Powderhorn Valley of Cebolla Creek, in Tps. 46-47 N., and Rs. 1, 1-1/2, and 2 W., New Mexico principal meridian, about 30 miles southwest of Gunnison (location 40, fig. 1). The district is reached by traveling over U.S. Highway No. 50 and Colorado State Highway No. 149. The deposits are near Powderhorn Post Office.

A large number of claims are held by the Gunnison Syndicate, W. K. McLennan, trustee, c/o Fred W. Buck, 205 Lonsdale Building, Duluth, Minn. New Jersey Zinc Co. also has holdings in the vicinity.

Iron was found in the Cebolla area before 1880. Production has been less than 4,000 tons.

Titaniferous magnetite occurs mainly in pyroxenite and to a lesser extent in other igneous rocks within the Iron Hill stockwork. The favorable pyroxenite rocks cover about 8 square miles. In addition, small deposits of limonite, hematite, and martite occur in carbonate-rich rocks (carbonatite) in the Iron Hill area. Titaniferous magnetite occurs as an intimate mixture of magnetite (Fe_3O_4) and perovskite ($CaTiO_3$), with some ilmenite ($FeTiO_3$), apatite ($Ca_{10}F_2(PO_4)_6$), biotite, and sulfides within pyroxenite rocks. The greater part of the pyroxenite rock mass is composed of pyroxene, biotite, apatite, magnetite, and perovskite with some manganese. The most abundant, and also the average, rock contains about 60 percent pyroxene, 15 percent biotite, 10 percent each of magnetite and perovskite, and less apatite, titanite, and ilmenite. The magnetite and perovskite generally tend to be in nearly equal proportions. Within this extensive but low-grade titaniferous magnetite-pyroxene rock mass are many comparatively small, local, podlike bodies of high-grade magnetite-perovskite; the best are almost pure, coarse-grained, intimate mixtures of magnetite and perovskite with a little ilmenite, titanite, apatite, and biotite.

The prospect pits in the carbonate-rich (carbonatite) rocks were dug on very small martite-apatite veins and small bodies of cellular and siliceous limonite and hematite that may be associated with martite. The deposits on Iron Hill appear small.

Analyses of samples of the large low-grade titaniferous magnetite area taken by the Bureau of Mines during 1957 are shown in table 16.

Early exploration included a few small pits, opencuts, and adits. Later work comprised two short adits and some core drilling by the New Jersey Zinc Co. and the Humphreys Gold Corp. During 1956 the Bureau of Mines sampled the Sammons Gulch, Deldorado, and Beaver Creek areas and in 1957 completed three core-drill holes in secs. 1 and 12, T. 46 N., R. 2 W. The results of that work will be published by the Bureau of Mines.

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TABLE 16. - Analyses of Cebolla Creek titaniferous magnetite (percent)

Sample No.	Fe	TiO_2	Mn	CaO	SiO_2	Description
1	24.8	32.7	0.12	17.6	5.2	Highest grade magnetite-perovskite SE1/4 sec. 1, T. 46 N., R. 2 W.
2	19.9	26.6	.30	15.8	13.6	Do.
3	30.8	20.4	.40	13.6	12.4	Massive magnetite from cut north of Deldorado Creek. SW1/4, sec. 1, T. 46 N., R. 2 W. (magnetite-augite-perovskite-vermiculite).
4	13.0	12.4	.36	19.8	30.4	Do.
5	26.2	16.7	.41	14.9	13.4	Sammons Gulch. Augite-biotite-magnetite. NE1/4 sec. 33, T. 47 N., R. 2 W.
6	15.0	17.8	.30	20.0	23.0	Massive magnetite. Cut and adjacent dump, S1/2 sec. 1, T. 46 N., R. 2 W.
7	18.7	17.0	.30	16.1	22.4	Magnetite-pyroxenite. Cut and dump, S1/2 sec. 1, T. 46 N., R. 2 W.
8	11.8	8.2	.30	17.5	34.1	Pyroxene-magnetite. East of Deldorado Creek. NE1/4 sec. 12, T. 46 N., R. 2 W.
9	8.6	3.8	.13	21.9	42.7	Augite-biotite-magnetite. Augite quarry. Block Mica Min. Co. SE1/4 sec. 12, T. 46 N., R. 1-1/2 W.
10	11.4	7.5	.20	18.0	29.2	Vermiculite-augite-magnetite. Mica shaft dump and adjacent outcrop. SW1/4 sec. 1, T. 46 N., R. 2 W.
11	12.2	10.1	.25	17.4	32.8	Do.
12	11.6	7.0	.20	13.4	40.1	11-foot auger hole along Deldorado Creek, NE1/4 sec. 11, T. 46 N., R. 2 W.
13	15.8	10.8	.30	11.8	36.6	Placer sample of sand in north fork Deldorado Creek bed. SE1/4 sec. 2, T. 46 N., R. 2 W.

The small amount of exploration and metallurgical work done to 1958 did not yield enough data for an accurate appraisal of the Cebolla Creek deposits. Low iron content makes them unattractive as an ore of iron alone, but their titanium content might make them valuable at some future time.

References: (2, p. 36; 3, pp. 569-572; 10, pp. 9-26; 12, pp. 266-273; 13, pp. 281-285; 43, p. 111; 44, pp. 101-102; 54, pl. 1; 56, pp. 197-198; 61; 68, pp. 267-273; 71, p. 125-145; 72, pp. 560-573.

Crested Butte Limonite

The deposit is known variously as the Iron Swamp, Crested Butte iron bog, Coal Creek bog iron, Jerry No. 1 mine, and is now part of the Keystone lead-zinc-copper mine operated by American Smelting and Refining Co. It is in the E1/2 sec. 6, T. 14 S., R. 86 W., sixth principal meridian, on the Park City group of lode claims (4, 45-48, B, C, F, and G) in the Elk Mountain mining district. The property is 2 miles west of Crested Butte, on Colorado State Highway No. 135, up Coal Creek (location 41, fig. 1).

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The limonite is of recent spring and bog origin. Ground waters circulating in iron-bearing sulfide deposits issue as springs from the steep hillside. Waters from the springs still are depositing limonite and other hydrous iron oxides over the swampy hillside, covering a trapezoidal area about 3,000 feet long in a north-south direction and 800 to 2,200 feet wide. The thickness of the deposit ranges from a film to more than 15 feet, and the limonite is exposed in several cuts on the road leading to the Keystone mine and in the roadcut of Colorado State Highway No. 135. The deposit extends below the highway to the swamp along Coal Creek.

A small production is reported to have been used as nonferrous smelter flux in the early 1800's. The analyses of two samples of the limonite are given in table 17.

TABLE 17. - Analyses of limonite from Crested Butte (percent)

Fe	P	S	SiO_2	Mn	Loss on ignition	Al_2O_3	CaO	MgO	Remarks
50.73	0.145	-	2.50	-	23.97	0.28	0.22	0.12	After burning the ore was enriched to 67 percent iron.
27.3	.13	0.53	35.2	0.2	15.6	-	-	-	Character sample taken by Bureau of Mines, 1957.

A spectrographic analysis shows 0.001-0.01 percent copper, gallium, zirconium, vanadium, and chromium; 0.01-0.1 percent lead and cobalt; and 0.1-1.0 percent titanium.

The limonite varies in character and iron content. In places it is nearly pure, porous, and firm limonite; in others it is mushy and mixed with swamp debris such as grass, wood, moss, etc.; elsewhere it is a cement, coating and binding talus, sand, and gravel. The deposit, although extensive, is believed too low grade to be a significant source of iron ore.

Workings other than mine adits consist of a few shallow pits, now inaccessible.

References: (2, p. 36; 8, pp. 13-24).

Cumberland Magnetite

The Cumberland deposit (fig. 7) is in sec. 32, T. 15 S., R. 81 W., sixth principal meridian, Tincup mining district, at an altitude of about 12,100 feet. It is covered by the Cumberland (survey 2357), Cumberland No. 2 (2357), Deadlock (2130), Iron Mountain (3721), Sinbad (2052), York (3719), and State of Maine (3720) patented lode claims. The magnetite outcrops and the Cumberland mine are 13 miles north of Pitkin, 8 miles south of Tincup, and 0.7 mile by road northeast of the crest of Cumberland Pass (location 42, fig. 1). The claims are the property of A. L. Pearson of Pitkin and George and Bert Tucker of Ohio, Colo. The claims were located August 31, 1895.

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Production of 530 tons of ore was reported in 1883, assaying 64 percent iron, 2 ounces of gold, and 6 ounces of silver a ton. The iron was used as non-ferrous smelter flux.

FIGURE 7. - Cumberland Magnetite Pit, Gunnison County, Colo. Width of magnetite shown in outlined section.

Magnetite, with some limonite, hematite, chalcopyrite, malachite and azurite, gold, and silver, occurs as a contact-metamorphic, replacement-type deposit in the calcareous parts of the Pennsylvanian Belden shale formation, associated with Tertiary intrusives. On the Cumberland claims the magnetite occurs in a layer of limestone lying between quartz diorite porphyry and the Tincup porphyry. Gangue minerals include quartz, serpentine, tremolite diopside, calcite, and brown garnet. Results of assays of the magnetite that were obtained from various sources are listed in table 18.

TABLE 18. - Analyses of magnetite from Cumberland deposit (percent)

Fe	P	S	SiO_2	Mn	CaO	Au	Ag	Remarks
59.8	0.01	0.21	8.0	0.2	-	-	-	Character sample by Bureau of Mines, 1957.
69.32	.039	.084	2.80	-	0.30	-	-	1887.
64.0	-	-	-	-	-	2.0	6.0	1883.

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A spectrographic analysis of the ore showed 0.001-0.01 percent gallium, lead, zirconium and indium; 0.01-0.1 percent tin, titanium, and cobalt; and 0.1-1.0 percent copper, zinc, and manganese.

Magnetite is exposed on the Cumberland claim (survey 2357) in a small cut, a caved adit, and small outcrops, and as float on the west slope of Cumberland Mountain (fig. 7). On the Cumberland No. 2 claim, adjacent to the Cumberland claim on the north, is a caved-in cut with a small dump containing abundant brown garnet. The deposit extends irregularly northwesterly along the strike of the bed for several hundred feet. Locally it is 10 feet thick. Corregan and Lingane (1883) described it as being a blanket-type deposit, 38 feet thick, consisting of magnetite, red hematite, and considerable gangue.

References: (7, p. 313; 12, pp. 266-273; 18, p. 327; 33, p. 60; 40, pp. 590-591.

Iron King Magnetite

Magnetite occurs on the Iron King, Iron Dyke, Ensign, and Parole lode claims (survey 4808) in the N1/2 sec. 35, T. 50 N., R. 5 E., New Mexico principal meridian, Tomichi mining district, at about 10,500 feet altitude. The old mine workings are 1.7 miles by road northeast of White Pine, on a steep and heavily forested slope (location 43, fig. 1). The property is owned by Ada Tallman and Robert Wells, of San Francisco, Calif., Mrs. Annie McMahon, Wheatland, Wyo., and Mrs. C. F. Clemmens, of White Pine, Colo.; part of it is leased to Vulcan Zinc-Lead Co., of Gunnison. The magnetite deposit was discovered in 1888.

Production before 1888 was reported as several carloads of iron ore shipped to the Tomichi Valley smelter at Gunnison for flux.

The magnetite, with a little pyrite, chalcopyrite, limonite, cuprite, azurite, and malachite, occurs as a contact-metamorphic, replacement-type deposit in the calcareous parts of limestone-shale beds. The gangue includes ocherous material, chlorite, calcite, epidote, tremolite, amphibole, pyroxene, serpentine, garnet, quartzite, shale, and limestone. The deposit is in the Pennsylvanian Belden shale formation associated with Tertiary quartz-monzonite intrusives. Generally, small magnetite outcrops and magnetite float are scattered over an area 600 to 1,200 feet wide (N.-S.), from the Iron King to the Ensign workings and about 1,800 feet long (E.-W.), from the Morning Glim fault downhill almost to the valley floor.

The magnetite area is cut at four switchbacks on the road between the valley floor (altitude 9,900 feet), and the Iron King cut and caved portal (altitude 10,500 feet). The magnetite zone exposed in the cuts is about 70 feet wide. Leith states, "One tunnel showed two seams 14 and 75 feet in width. The ore was not followed along the strike for any great distance but is said to extend to Marshall Pass, several miles away." Dings and Robinson mention thicknesses of 5 to 40 feet and widths of several hundred yards.

Assays of the ore given in various reports are listed in table 19.

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TABLE 19. - Analyses of Iron King magnetite deposit (percent)

Fe	P	S	SiO_2	Mn	Remarks
58.75	0.044	0.123	3.85	-	1897.
59.32	.036	-	7.9	-	Average of 10 samples by Birkenbine.
50.90	.03	.30	17.2	0.3	Character sample by Bureau of Mines, 9/16/57.

A spectrographic analysis shows 0.001-0.01 percent gallium, indium, zirconium, and chromium; 0.01-0.1 percent tin, lead, titanium, and cobalt; and 0.1-1.0 percent copper, zinc, and manganese.

Pits, shafts, and shallow adits on the property are inaccessible. The best exposure of magnetite is at the Iron King cut.

References: (2, p. 36; 10, pp. 9-26; 12, pp. 266-273; 13, pp. 281-285; 14, p. 28; 33, pp. 46-47, 80, pl. 5; 41, pp. 196-197; 44, pp. 101-102; 56, pp. 196-198).

Iron Ore Lode Magnetite

Magnetite (fig. 8) occurs in a rugged, heavily forested area in the SE1/4 sec. 6, T. 15 S., R. 81 W., New Mexico principal meridian, Tincup mining district, on the Iron Ore Lode and Iron Ore No. 2 Lode (survey 5021), patented claims owned by Joe Barer, 622 Mining Exchange Building, Denver, Colo. (location 44, fig. 1). It was discovered by W. H. Whalin in 1888. The property is 1.5 miles by road northwest of the Tincup church.

A northwesterly striking outcrop of magnetite, with some pyrite, chalcopyrite, azurite, and malachite, forms part of a prominent ridge on the Iron Ore Lode claims. The magnetite occurs as a contact-metamorphic, replacement-type deposit in Carboniferous limestone associated with a diorite(?) intrusive. The magnetite outcrop is traceable along the ridge for about 400 feet northwesterly in widths of 65 to 100 feet. Its true thickness could not be determined. The deposit appears to dip 58° NE. Character samples of the ore assayed as shown in table 20.

TABLE 20. - Analyses of magnetite from Iron Ore outcrop (percent)

Fe	P	S	SiO_2	Mn	Cu	TiO_2	Remarks
54.1	0.03	0.21	4.4	0.1	-	-	Character sample taken by Bureau of Mines, 9/17/57.
56.2	.01	.02	4.7	0.80	.5	nil	Character sample (1933).

A spectrographic analysis shows 0.001-0.01 percent gallium, indium, lead, zirconium, and chromium; 0.01-0.1 percent tin, titanium, cobalt, and nickel; and 0.1-1.0 copper, zinc, and manganese.

The property was prospected with several pits and shallow shafts, now caved and inaccessible. There was no known production of ore.

Reference: (Gunnison County records; and A. L. Pearson of Pitkin, Colo).

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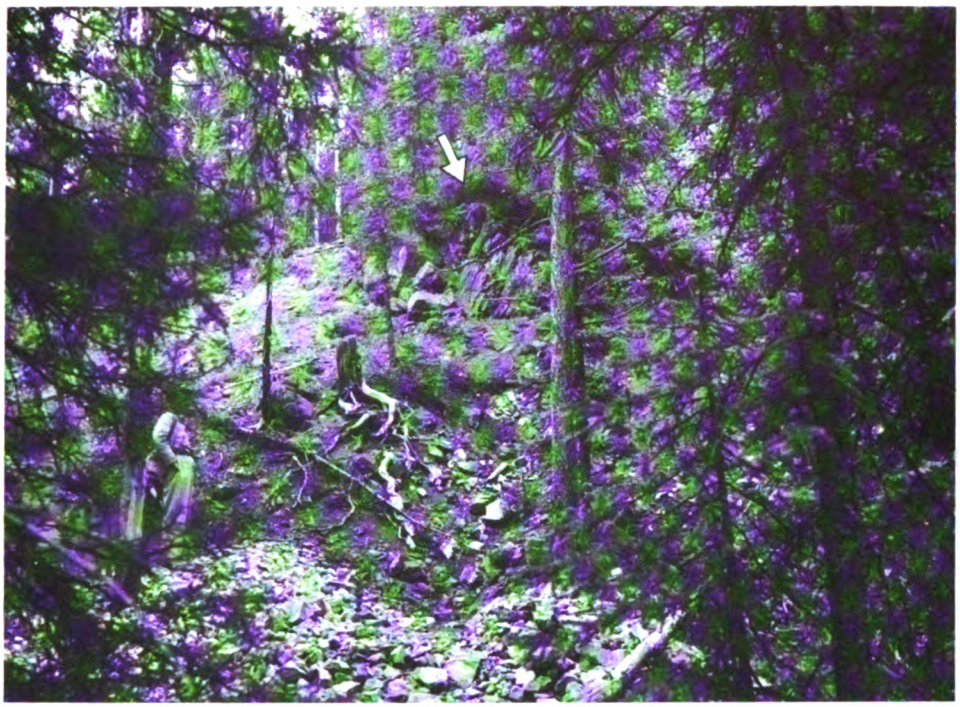

FIGURE 8. - Iron Ore Lode Magnetite Outcrop, Gunnison County, Colo.
Arrow points to outcrop.

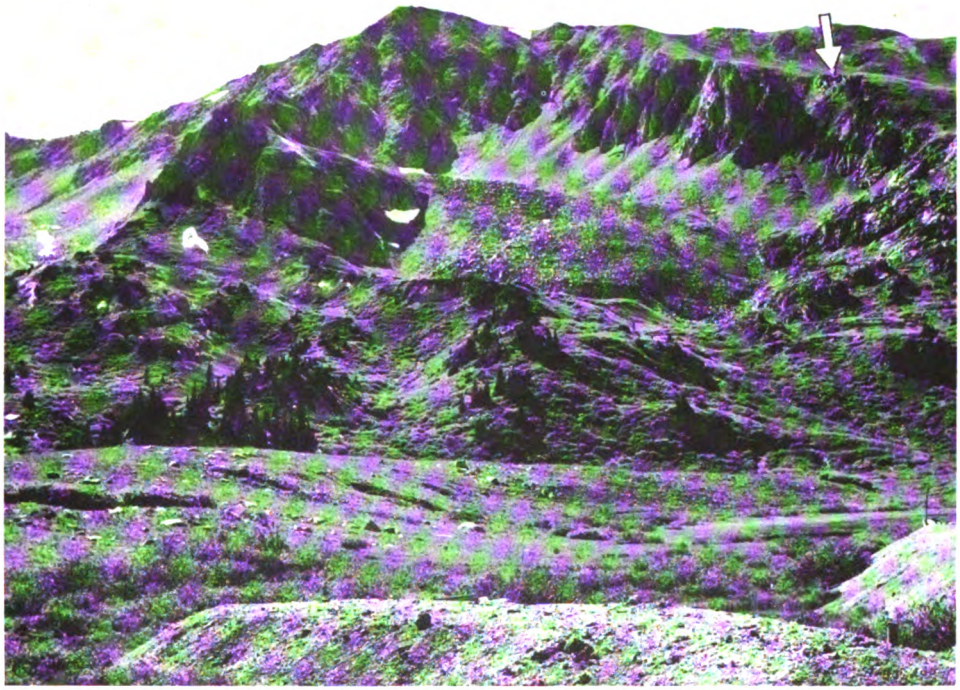

FIGURE 9. - Mount Tilton Magnetite, Gunnison County, Colo.
Arrow points to outcrop.

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Mount Tilton Magnetite

Magnetite crops out on the south slope of Mt. Tilton (fig. 9) approximately in unsurveyed sec. 2, T. 13 S., R. 84 W., sixth principal meridian, Taylor Peak mining district, at about 12,000 feet altitude (location 45, fig. 1). The deposit can be seen by looking S. 80° E. from the Star mine, but access is difficult on foot. The deposit is on one of the Star group of claims. No ore has been produced from the deposit.

Magnetite, with some pyrite, chalcopyrite, limonite, azurite, and malachite, occurs as a small, irregular, contact-metamorphic replacement-type deposit that more or less parallels the enclosing limestone bedding at or near a diorite intrusion. Nearby limestone strikes N. 30° W. and dips 65° SW., but both the strike and the dip vary widely within short distances. The magnetite can be traced by outcrops and float for a length of 100 feet over widths of 20 to 50 feet. The true thickness and extensions are not disclosed. A character sample taken by the Bureau of Mines September 14, 1957, contained 58.2 percent iron, 0.03 percent phosphorus, 0.23 percent sulfur, 4.6 percent silica, and 0.6 percent manganese.

A spectrographic analysis shows 0.001-0.01 percent gallium, indium, zirconium, and chromium; 0.01-0.1 percent tin, titanium, cobalt, and nickel; and 0.1-1.0 percent copper, zinc, and manganese.

The deposit appears small and is hard to reach.

References: (35, pp. 2-3; 41, pp. 188-198).

Redwell Basin Limonite-Hematite

Deposits of limonite occur in Redwell Basin, 10.1 miles by road northwest of Crested Butte, at 10,300 feet altitude, in the Ruby mining district, approximately in secs. 24-25, T. 13 S., R. 87 W., sixth principal meridian (location 46, fig. 1). The deposits are part of Crested Butte Mining and Milling Co. property. No iron ore has been produced from the property.

Limonite with some hematite forms a spring-type deposit at the Red Well in the upper part of the Redwell Basin, where hydrous iron oxides are precipitated from iron-charged meteoric water issuing as a spring from Cretaceous Laramie rocks. Farther down the basin another spring-type deposit of limonite-hematite is being formed from water issuing from a shallow shaft into Redwell Creek. Bog hematite is being deposited in the swampy parts of the Redwell Creek drainage. The deposits are up to 5 feet thick and occupy an aggregate area about 600 feet long and 75 feet wide. A character sample of the better grade of limonite taken by the Bureau of Mines, September 18, 1957, assayed 49.6 percent iron, 0.17 percent phosphorus, 1.90 percent sulfur, 5.2 percent silica, 0.1 percent manganese, and 21.4 percent loss on ignition.

A spectrographic analysis shows 0.001-0.01 percent indium, zirconium, and vanadium and 0.01-0.1 percent copper, lead, titanium, and manganese.

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Workings in the iron consist of one shallow shaft. The deposits are small and unimportant as a source of iron; access to them is difficult.

References: (2, p. 36; 35, pp. 2-3).

Taylor Peak Magnetites, Southeast Slope

Magnetite occurs in six small deposits high on the southeast slope of Taylor Peak above Taylor River, in unsurveyed approximate sec. 22, T. 12 S., R. 84 W., sixth principal meridian, Dorchester (Taylor River) mining district, at an altitude of 12,000 to 13,000 feet (location 47, fig. 1). Ownership of the deposits is obscure, and there is no record of any production.

Magnetite, with some limonite, chalcopyrite, pyrite, garnet, epidote, pyroxene, amphibole, chert, calcite, and chlorite, occurs as small, irregular, contact-metamorphic, replacement-type deposits along the contact between Pennsylvanian Weber formation (shale and limestone) and a Tertiary diorite intrusive. There probably are many other small magnetite deposits scattered between Taylor and Star Peaks and beyond. The deposits are scattered along a northerly trending contact length of 300 feet. The largest magnetite body observed is exposed over a 100- by 200-foot area and is a short distance southeast of the summit of Taylor Peak. The deposits are similar to that on Twenty Percent Creek and the large deposit on Coopers Fork, farther north in Pitkin County. A character sample of the better magnetite and a manganiferous limonite assayed as shown in table 21.

TABLE 21. - Analyses of magnetite from Taylor Peak deposit (percent)

Fe	P	S	SiO_2	Mn	Remarks
66.9	0.03	0.43	1.5	0.2	Character sample by Bureau of Mines, 9/14/57.
34.5	-	-	-	13.6	Made in 1890.

The deposits appear small and access is difficult.

References: (12, pp. 266-273; 41, pp. 189, 192, 193).

Twenty Percent Creek Magnetite

A small deposit of magnetite occurs at the head of Twenty Percent(?) Creek on the east slope of Taylor Peak, in unsurveyed approximate sec. 22, T. 12 S., R. 84 W., sixth principal meridian. It is in Gunnison National Forest, Dorchester (Taylor River) mining district, between altitudes of 11,000 and 12,000 feet (location 48, fig. 1). There is no record of any production from the deposit.

Magnetite, with some pyrite, chalcopyrite, limonite, azurite, malachite, and a variety of contact-metamorphic minerals, occurs as a small, irregular, contact-metamorphic, replacement-type deposit in a calcareous unit of the Pennsylvanian Weber formation, associated with a Tertiary dioritic intrusive. Magnetite outcrops and float cover an area extending 200 feet northeasterly

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by 200 feet northwesterly. A character sample of the magnetite was taken by the Bureau of Mines September 13, 1947. It assayed 66.6 percent iron, 0.03 percent phosphorus, 0.23 percent sulfur, 1.0 percent silica, and 0.1 percent manganese.

A spectrographic analysis indicates 0.001-0.01 percent gallium, zirconium, vanadium, and chromium; 0.01-0.1 percent copper, lead, titanium, and cobalt; and 0.1-1.0 percent zinc and manganese.

The deposit is small and access is difficult. It has been prospected with three shallow pits, now sloughed in.

Reference: (41, pp. 188-198).

Fossil Ridge Magnetite

Magnetite occurs in the approximate SW1/4 sec. 22, T. 51 N., R. 3 E., New Mexico principal meridian, about 1-1/4 miles northeast of the old Carbonate Camp and 5-1/2 miles northerly from Ohio (location 49, fig. 1). It is on Fossil Ridge, above the head of Comanche Creek, in the Gold Brick mining district, at 11,500 feet altitude.

Magnetite with some limonite, calcite, garnet, and marble is poorly exposed in three shallow pits as one or more replacement-type deposits, along the contact between a large mass of andesite porphyry and Mississippian Leadville limestone. Access to the deposit is difficult, and it is too small to be considered a commercial source of iron ore.

References: (22, pp. 78, 81, pl. 11).

Carbonate Camp Hematite

Hematite occurs near Carbonate Camp in approximate sec. 28, T. 51 N., R. 3 E., New Mexico principal meridian, in the Gold Brick mining district, at an altitude of 11,500 feet (location 50, fig. 1). There is no recorded production.

Red hematite, probably turgite, was taken from a shallow prospect hole a few hundred feet from the outcropping andesite porphyry, about 500 feet north of Carbonate Camp. The occurrence is poorly exposed and too small to be considered a commercial source of iron ore.

Reference: (22, p. 78, pl. 11).

Miscellaneous Iron Occurrences

A body of hematite has been reported in crystalline schist in Cochetopa Creek, south of Parlin (location 51, fig. 1). The deposit could not be located in the field.

Reference: (43, p. 109).

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Limonite-siderite nodules are reported in the Cretaceous coal formation, 4 miles east of Mount Carbon. The site is accessible by way of Ohio Creek, 18 miles from Gunnison (location 52, fig. 1). Limonite resulting from weathered siderite occurs in thin horizontal seams in the coal measures. The nodules reportedly contain about 50 percent iron.

Reference: (61).

A number of small magnetite and hematite occurrences have been reported along the flanks of the Elk Mountains in Pitkin and Gunnison Counties at and near the contact of Tertiary dioritic intrusives with the Pennsylvanian Weber formation and Mississippian Leadville limestone. They occur at intervals between Italian Mountain and Mount Tilton, Star Peak, Taylor Peak, and beyond and are above timberline at altitudes of 12,000 to 13,000 feet (general location 53, fig. 1).

References: (35, p. 5; 41, pp. 188-196).

Burchard reports that a large body of strong iron ore wss found with a 9-inch quartz vein on the Iron Cup claim (general location 54, fig. 1), west of the Little Gold Cup claim on Gold Hill, Tincup mining district, in T. 15 S., R. 82 W., sixth principal meridian. The property was developed by two shafts, 50 and 20 feet deep, and 30 feet of drifting. The ore ran 80 to 250 ounces of silver a ton.

Reference: (7, p. 313).

The Josephine claim on West Gold Hill (general location 54, fig. 1) was reported to have a 115-foot shaft and 90 feet of adit. A 12-foot iron vein at the bottom of the shaft contains as much as 40 ounces of silver a ton.

Reference: (7, p. 315).

The Belcher lode north of the Gold Cup on Gold Hill (general location 54, fig. 1) was reported to have 7 feet of decomposed iron carbonate containing 30 ounces of silver a ton.

Reference: (7, p. 313).

The M.C.R.R. hematite prospect is reported to be near the Cumberland mine on Gold Hill (location 42, fig. 1). Burchard says the mine is entirely in porphyry and has a 17-foot-thick vein (dike) of solid iron ore that crops out for 84 feet. The ore is reported to be pure hematite running 65 to 78 percent iron and 8 to 12 ounces of silver a ton.

References: (7, p. 313; 40, p. 591).

The Little Bertie lode (location 54, fig. 1) was reported to contain copper-stained, magnetic iron ore averaging 65 percent iron and 10 to 15 ounces of silver a ton.

Reference: (7, p. 319).

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A small bog limonite deposit occurs 1-1/2 miles above Whitepine. It is exposed in a shallow cut near Tomichi Creek in the Tomichi (Whitepine) mining district, T. 50 N., R. 5 E., New Mexico principal meridian, at an altitude of about 10,000 feet (location 55, fig. 1). It is exposed in a cut to a depth of about 3 feet as porous brown limonite and bog debris. The limonite has been precipitated along the swampy channel of Tomichi Creek from ferruginous meteoric waters that have been in contact with oxidixing iron sulfides.

References: (20, p. 294; 41, p. 198; 46, p. 40; 81, p. 88).

A body of magnetite, 4 to 5 feet thick, is reported near Snowmass Mountain on the North Fork of the Crystal River (formerly Rock Creek) in approximate sec. 30, T. 11 S., R. 87 W., sixth principal meridian, Rock Creek mining district (location 56, fig. 1). The ore is reported to contain 60 to 70 percent iron and a small amount of sulfur and phosphorus, but it is free of titanium.

Reference: (15, pp. 28-29).

Hinsdale County

Wager Gulch Limonite

A deposit of limonite occurs at the upper end of a large bog above the forks of Wager Gulch, in approximate secs. 24 and 25, T. 42 N., R. 5 W., New Mexico principal meridian, Carson mining district (location 57, fig. 1). The deposit is about 1 mile below Batchelor, at an altitude of about 10,000 feet. It is 14 miles south of Lake City by way of Colorado State Highway No. 351 and a rough access road.

Limonite occurs as a variety of yellow, red, and brown hydrous iron oxides in a bog-iron deposit that still is being formed. The deposit varies in composition, texture, and iron content. The iron apparently is taken into solution by meteoric waters that pass through oxidizing, iron-sulfide-bearing rocks and veins. The water issues from the base of cliffs as ferruginous springs from which the iron is precipitated as limonite bog iron in the swampy bottom of Wager Gulch. A small amount of the limonite was used as nonferrous smelter flux at Lake City in the late 1800's. The deposit is not a commercial source of iron ore but may be useful for special purposes.

Reference: (55, p. 35).

Huerfano County

Walsenburg Limonite-Siderite

Siderite, altered to limonite, is in the form of concretionary masses near the base of the Cretaceous Laramie formation. The deposits are thin and scattered (general location 58, fig. 1). A sample of concretionary limonite and siderite taken 3 miles south of Walsenburg had a variable composition, depending on the degree of weathering. The outer limonitic layer

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contained 27.86 percent iron and 1.196 percent phosphorus; the siderite kernel contained 15.66 percent iron and 0.561 percent phosphorus.

Reference: (66, pp. 472-485).

Jefferson County

Kennedy Gulch Magnetite

A band of magnetite-garnet gneiss occurs in the Precambrian Idaho Springs formation in secs. 3, and 4, T. 7 S., R. 70 W., sixth principal meridian on the northeast side of Kennedy Gulch at an 8,100-foot altitude (location 60, fig. 1). The band is 10 to 67 feet wide, and magnetite was proved by core drilling to extend to a depth of more than 200 feet. The magnetite occurs as narrow stringers and blebs, which in places may constitute 90 percent of the rock. Magnetite float was found 1 mile east of Kennedy Gulch on the projection of this occurrence.

Jefferson County Iron Mines

Magnetite in pegmatitic amphibole schist was reported near the head of Strain Gulch (general location 59, fig. 1). It was discovered in 1880 and known as the Jefferson County Iron Mines. The deposit is about 2,000 feet above the mouth of Strain Creek Gulch, which is 1-1/4-miles south of Morrison. A sample of the better grade magnetite, which appears to be only a minor rock constituent, contained 20.56 percent iron and 0.069 percent phosphorus.

Three small pits were dug in the schist in 1880. The occurrence has no merit as a commercial source of iron.

Reference: (66, pp. 476-477).

Miscellaneous Iron Occurrences

Nodules of siderite, altered to limonite and hematite, occur in the Cretaceous Benton group of shales between Morrison and Soda lakes, in sec. 1, T. 5 S., R. 70 W., sixth principal meridian, (general location 59, fig. 1). A small production from near Morrison was used as paint pigment and was considered a source of iron ore in 1885. A sample assayed 22.9 percent iron, 26.31 percent silica, 2.31 percent alumina, 3.22 percent lime, and 8.19 percent magnesia.

It is not now a commercial source of iron.

References: (3, pp. 569-572; 8, pp. 13-24).

Lake County

Leadville Iron Occurrences

The Leadville district is in T. 9 S., Rs. 79 and 80 W., sixth principal meridian, at altitudes of 10,000 to 11,000 feet. It includes the town of Leadville (general location 61, fig. 1).

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Limonite, hematite, magnetite, siderite, and manganosiderite were known in the Leadville district before 1886, when the first known shipments were used as flux in local nonferrous smelters. Between 1891 and 1925 approximately 810,000 tons of manganiferous iron ore and 2,900,000 tons of iron-silver and iron-manganese-silver ore of various grades were produced. The manganiferous ore was used to make ferromanganese and spiegeleisen; the iron-silver and iron-manganese-silver ores were used mainly as metallurgical flux. A small quantity of the better grade iron ore was used by the Colorado Fuel and Iron Corp. and by others in the iron industry. Its iron content varied from about 20 to 68.3 percent. The iron ore last produced in Leadville (1945-46) was red hematite from the Breece mine.

Iron reportedly was found in many mines in the district, but available records of the production are incomplete. It is impossible to determine the extent and quality of remaining iron-ore reserves without conducting an extensive exploration program, and this would be difficult because many shafts and underground workings are now caved, flooded, or otherwise inaccessible.

Iron minerals occur in irregular, replacement-type deposits in Mississippian Leadville limestone as magnetite, limonite, hematite, some manganosiderite, and siderite, plus quartz, epidote, chlorite, wollastonite, serpentine, and clay. The iron is associated also with marmatite, sphalerite, galena, pyrite, and their oxidation products, and some gold and silver.

In the sulfide-zone magnetite occurs as irregular gray to black masses up to 300 feet long and up to 80 feet wide and thick, that also contain some specularite, manganosiderite, pyrite, and quartz. Hematite is abundant in the Leadville ores and occurs as specularite in the high-temperature-type ores. Magnetite and the massive dark-red siliceous variety of hematite have been a source of high-grade ore at the Breece (Penn) iron mine. It evidently was formed by the oxidation of magnetite and pyrite.

In the oxidized zone, brown to yellowish, earthy limonite and goethite and the red turgite form a large proportion of the oxidized ores of the district and also appear as stains and coatings on rocks and siliceous ores. They have resulted from the decomposition of pyrite, marmatite, siderite, and magnetite. They also result from the alteration of hornblende and biotite in weathered eruptive rocks. These iron oxides are associated with various proportions of manganese oxides and kaolin. The manganese oxides occur in a variety of earthy and hydrated oxides difficult to recognize and include pyrolusite, psilomelane, and wad.

Production of 212,000 tons of oxidized iron-manganese ore used as smelter flux during 1915-25 assayed 31 to 44 percent iron, 12 to 17 percent manganese, a trace of copper, 0.6 to 2.1 percent lead, 11 to 18 percent silica, and as much as 0.014 ounce of gold and 5 to 9 ounces of silver a ton.

The analyses of 121,000 tons of manganiferous limonite-hematite iron ore shipped to the Colorado Fuel and Iron Corp. from Leadville (in 1926, 1932, and 1940) contained 16 to 26 percent iron, 18 to 23 percent manganese, a trace to 1.6 percent zinc, and up to 2.5 percent lead. The ores were used to make spiegeleisen.

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Table 22 gives selected assays, obtained from various sources, showing the quality of the ores mined before 1926 and indicating what might be expected in remaining ore bodies.

TABLE 22. - Analyses of iron ores from mines of Leadville district (percent)

Mine	Fe	Mn	P	S	SiO_2	Ag	Remarks
Breece.....	68.3	0.08	0.005	0.102	1.18	-	Magnetite and red hematite (1886).
Breece.....	56.06	.17	.12	-	5.26	-	Hematite-magnetite from open pit (1946 production).
Amie.....	50.20	Trace	.076	-	-	-	Limonite, brown ore.
Ballou.....	48.51	9.30	.018	.055	-	-	Brown ore.
Maid and Henrietta...	41.48	14.71	.039	.055	5.00	-	Do.
Catalpa.....	37.1±	20.2	.007	.052	6.7	-	Do.
Morning and Evening Star	31.8	18.8	-	-	10.4	10.3	Do.
Hull.....	32.0	17.0	-	-	5.0	-	Do.

Average analyses of manganiferous siderite from six properties near Leadville were 27.30 percent iron, 13.44 percent manganese, 0.82 percent lime, and 9.48 percent insoluble matter.

Little can be said about iron-ore reserves in the Leadville area other than it is inferred that large reserves of better-than-30-percent iron-manganese rock remain.

References: (1; 12, pp. 266-273; 37, pp. 131, 150, 177-178, 296-297); 42, pp. 137-145; 43, p. 111; 59, pp. 36-37; 66, pp. 538-539; 68, pp. 267-273; 80, pp. 407-410; 81, p. 88).

Miscellaneous Iron Occurrences

Numerous masses of magnetite, some of considerable size, are reported to occur throughout the Paleozoic(?) Twin Lakes quartz monzonite porphyry between Twin Lakes and Everett, and beyond, in Tps. 11-12 S., Rs. 81-82 W., sixth principal meridian (approx. location 62, fig. 1). The porphyry is exposed along Lake creek, covers a large area in the Twin Lakes mining district of Lake County, and extends into the La Plata district of Chaffee County.

Stringers of pegmatite consisting of quartz and magnetite are common occurrences in the vicinity of Casco Peak, T. 11 S., R. 81 W., and Mount Champion, Tps. 10-11 S., R. 82 W., where they inject Precambrian gneiss and schist. The injection of the Casco Peak schists is reported so intense as measurably to affect magnetic declination.

Magnetite occurs on the Duke Nos. 1 to 3 claims at the head of Corskey Creek on the east slope of Mt. Elbert, in approximate sec. 10, T. 11 S., R. 80 W., sixth principal meridian, about 2-1/2 miles northwest of Twin Lakes (location 63, fig. 1). The claims are the property of Bert Morain of Coal

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Creek. Magnetite is poorly exposed for about 75 feet in Precambrian gneiss as masses and disseminations.

Hematite is reported to occur in small veins in an alaskitic dike at the head of Fryingpan Creek.

Reference: (49, pp. 50, 57, 104).

La Plata County

Babcock Peak Magnetite

Magnetite was found just east of Babcock Peak at an altitude of 12,000 feet, in approximate sec. 27, T. 37 N., R. 11 W., New Mexico principal meridian. The deposit is in the California (La Plata) mining district (location 64, fig. 1).

It is a replacement-type deposit in a small remnant of Jurassic Wanaka formation, known as the La Plata or Pony Express limestone, associated with a diorite(?) intrusive. The deposit contains magnetite and some martite with a little pyrite, hematite, limonite, and the contact-metamorphic minerals garnet, augite, and epidote.

The deposit is irregular and of limited exposure. It is not considered a commercial source of iron.

Reference: (30, pp. 13, 14; 32, p. 60).

Larimer County

Langford-Trail Creek Magnetite

A narrow band of magnetite in Precambrian schist is reported at the Langford-Trail Creek mine (location 66, fig. 1) in approximate T. 11 N., R. 72 W., sixth principal meridian, Roosevelt National Forest. The occurrence is about 14 miles southwesterly over dirt road, from Tie Siding, Wyo. It was developed before 1900 as a copper-gold prospect. The 147-foot shaft and 22-foot crosscut on the property are inaccessible. Early reports state that the magnetite was exposed as a continuous vein for the full depth of the shaft and over a width of 20 feet in the crosscut. It is reported traceable for 3,000 feet on the surface. A character sample of the better-grade magnetite taken from the mine dump contained 63.4 percent iron, 0.008 percent phosphorus, 0.01 percent sulfur, a trace of titanium, 0.1 percent lime, and 32.0 percent silica. The sample was taken by the Bureau of Mines in 1944.

There has been no production from the property.

Miscellaneous Iron Occurrences

Small veins of hematite are reported in granite a few miles northwest of Livermore and west of Fort Collins (location 65, fig. 1). They are small and unimportant commercially.

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Reference: (42, p. 109).

Las Animas County

Trinidad Limonite-Siderite

The only known iron in the Trinidad area is in bands of impure limonite-siderite concretions and nodules in the shaly portions of the Cretaceous Laramie formation that crop out over large areas. The greater part of the beds is too low in iron content and too thin to be considered a commercial source of iron.

The coal-bearing formations near Trinidad, especially those near Gray Creek in T. 33 S., R. 63 W., sixth principal meridian, are reported to have thin beds of nodular limonite-siderite intercalated with clay and shale - in some places throughout thicknesses of as much as 40 feet. A sample contained 35.03 percent iron.

Iron concretions also are found towards the base of the Laramie formation in the Spanish Peaks quadrangle, west of Trinidad (location 67, fig. 1). A thin bed of limonite-siderite concretions lies a few feet above the coal at the El Moro mine. Analyses of samples are shown in table 23.

TABLE 23. - Analyses of limonite-siderite concretions, El Moro mine (percent)

Fe	P	S	SiO_2	Al_2O_3	CaO	MgO	Loss on ignition	Remarks
53.07	0.047	-	-	-	-	-	-	El Moro Coal mine, Trinidad; thin seams above coal.
35.03	.46	-	9.19	6.29	4.02	1.37	33.035	Analysis of ironstone near Gray Creek; Upper Laramie formation.
4.76	-	-	-	-	-	-	-	Unaltered fresh gray siderite south of Trinidad.
43.93	-	-	-	-	-	-	-	Reddish-brown limonitic nodules south of Trinidad.

A small production was used in early-day smelters.

References: (8, pp. 13-24; 36, p. 339; 38, pp. 204-205; 47, p. 6; 48, p. 4; 66, pp. 484, 538-539, and table 25.

Moffat County

Paint Iron Mine Hematite

A small deposit of hematite occurs at the Paint Iron mine (fig. 10), on public domain, in the SW1/4 sec. 16, T. 7 N., R. 101 W., sixth principal meridian, Douglas Mountain mining district (location 68, fig. 1). The iron-bearing outcrop is just above the bottom and on the northwest side of an

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unnamed gulch, 3,500 feet southeast of the Bromide copper mine. The Bromide mine is 7 miles southwest of Greystone. There is no authentic record of production; the mine was reportedly prospected for paint pigment.

FIGURE 10. - Paint Hematite Mine, Moffat County, Colo. Arrow points to adit portal and outcrop.

Hematite, limonite, and ocherous material occur in a sandstone bed about 6 feet thick, overlain by sandstone and limestone. Most of the deposit is hard, blue-to-black hematite mixed with limonite and considerable low-grade, ocherous material. The deposit is traceable for about 235 feet along its strike of N. 58° W. and for about 50 feet down its dip of 26° SE. The deposit was prospected years ago with a 50-foot adit driven N. 65° W. The adit is 20 feet above the bottom of the gulch. The exposed ore thickness is 6 to 7.2 feet. A channel sample of hematite, taken over a thickness of 7.2 feet, 10 feet back from the face of the adit, assayed 35 percent iron, 0.08 percent phosphorus, 0.12 percent sulfur, 29.8 percent silica, and $<$0.1 percent manganese. Its loss on ignition was 5.1 percent.

A spectrographic analysis shows 0.001-0.01 percent copper, gallium, ytterbium, vanadium, and chromium; 0.01-0.1 percent lead, zinc, manganese, and nickel; and 0.1-1.0 percent titanium.

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The deposit is small with a variable iron content. It is too low grade and too inaccessible to be considered a commercial source of iron ore.

Reference: (2, p. 12).

Miscellaneous Iron Occurrences

Hematite and limonite were found on property known as the Iron Deposit and the Iron Mine, in sec. 26, T. 7 N., R. 101 W., sixth principal meridian, within the Dinosaur National Monument (location 69, fig. 1). A mixture of hematite and limonite occurs along the bedding planes and fractures in limestone. Although specimens of pure, partly crystalline hematite are exposed, the occurrence is small and spotty. It had been prospected with several pits and a 60-foot adit, now inaccessible. The pits are in two groups about 2,000 feet apart. The adit is near the southeast group of pits.

An iron deposit is reported on Zenobia Mountain, some 5 or 6 miles northwest of the Bromide mine, in the Douglas Mountain mining district (approx. location 70, fig. 1). It is in approximate secs. 28-33, T. 8 N., R. 102 W., sixth principal meridian, within the Dinosaur National Monument. The deposit consists of hematite, limonite, and ocher and is not considered a commercial source of iron ore.

Montezuma County

Indian Trail Ridge Magnetite

Magnetite was found on Indian Trail Ridge on the northeast slope of Diorite Peak in approximate secs. 13 and 24, T. 37 N., R. 11 W., New Mexico principal meridian. The deposit is at an altitude of 12,100 feet, on public domain, in the California mining district (location 71, fig. 1).

Magnetite, with some martite, hematite, limonite, pyrite, and the contact-metamorphic minerals garnet, augite, hornblende, and epidote, occurs in irregular, replacement-type deposits in remnants of the Jurassic Wanaka formation, known also as the La Plata and Pony Express limestone. The deposits are associated with diorite intrusives. The enclosing rocks are variable in strike, but trend northeasterly and dip 5° to 15° westerly.

The deposits appear small; they are not much more than 1 foot thick and are not considered to be a commercial source of iron ore.

References: (30, p. 13; 32, p. 60, pl. 2).

Rush Basin Bog Limonite

Limonite occurs in approximate secs. 31 and 32, T. 37 N., R. 11 W., New Mexico principal meridian, in Rush Basin, on the East Mancos River, California mining district, 10 miles northwest of Hesperus, at an altitude of 11,300 feet (location 72, fig. 1). There has been no production from the deposit.

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Limonite is extensively deposited in Rush Basin, below the Doyle mine, over a width of some 1,000 feet, a length of 1-1/2 miles, and in thicknesses varying from a coating to about 10 feet. The limonite is being precipitated from ground waters that have passed through sulfide-bearing beds and veins. The bog deposit varies in composition, texture, and iron content from almost pure limonite to impure, loose, unconsolidated, mushy-to-firm mixtures of limonite, bog material, sand, and gravel. Limonite also occurs as a coating and cement. Specks of pyrite are present, and the deposit is reported to contain a small amount of gold.

Workings consist of an old, inaccessible shaft.

References: (30, p. 14; 32, p. 60).

Ouray County

Dunmore Mine Hematite

Hematite occurs at the Dunmore mine on the patented Dunmore claim (survey 20608), on Silver Creek, in unsurveyed T. 43 N., R. 7 W., New Mexico principal meridian, Red Mountain mining district (location 73, fig. 1). It is a quarter of a mile southwest of the confluence of Red Mountain Creek with the Uncompahgre River and at an altitude of 9,400 feet. Production from the property was limited to some gold, silver, copper, and tungsten ores (1917).

The hematite is in a breccia chimney or pipe within a fault fissure. Fine-grained siliceous material is widely replaced by specular hematite. The replacement is reported complete enough to constitute a potential source of iron ore.

The Dunmore mine workings consist of two adits on the Dunmore claim, at altitudes of 9,100 and 9,400 feet. The hematite pipe is cut in the upper adit.

References: (53, pp. 362-365, fig. 11).

Guston Mine Limonite

Limonite occurs at the Guston mine in approximate secs. 11 and 12, T. 42 N., R. 8 W., New Mexico principal meridian, about halfway between Ironton and Red Mountain village, at an altitude of 10,600 feet on Red Creek (location 74, fig. 1). The deposits were known before 1882.

The limonite is reported as being precipitated from water issuing from the hillside about 150 feet above the Guston mine and from a mine tunnel driven into the limonite. Limonite has been deposited downslope from the mine and also has cemented the mine dump into a firm, ferruginous mass.

References: (24, p. 33; 67, p. 113).

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Ironton Park Limonite

Limonite occurs in Ironton Park, along U.S. Highway No. 550, in approximate secs. 1, 11 and 14, T. 42 N., R. 8 W., New Mexico principal meridian, between Red Mountain Village and Ironton (location 75, fig. 1). This deposit was known before 1882. There has been no known production from it.

Ferruginous springs have deposited limonite in the marshy upper basin of Red Mountain Creek. Although extensive, the deposits are shallow and very low grade. They consist of creek gravel and some bog debris which is loosely and thinly cemented with limonite. There are no workings, and the deposit has never been exploited.

References: (7, p. 381; 17, p. 190, map; 24, pp. 33, 34; 67, p. 113).

Miscellaneous Iron Occurrences

Magnetite-pyrite occurs at the Iron Clad mine, 1 mile north of Ouray, and 0.3 miles farther northwest, at the Bright Diamond mine. Both mines are on the east wall of Uncompahgre Canyon, near Bridal Veil Falls, in unsurveyed T. 44 N., R. 8 W., New Mexico principal meridian (location 76, fig. 1).

The ore is an intimate mixture of dense, granular magnetite and pyrite, with some chalcopyrite, gold, epidote, garnet, actinolite, quartz, and calcite, in a 10- to 15-foot-thick bed of bluish limestone of Jurassic age. The ore occurs in small, flat shoots conforming to the flat bedding and averages about 6 feet thick. The deposits are too small and the magnetite too dispersed to be commercial sources of iron.

References: (2, p. 37; 25; 50, pp. 73-75).

A thin sheet of ferruginous red tufa is being deposited on the eastern side of the alluvial flat of Uncompahgre Park, 2 miles southeast of Ridgeway (location 77, fig. 1). The deposit covers several acres and is formed from spring waters charged with iron.

Reference: (25, 20 pp.).

Park County

Tarryall Creek Mining District Magnetite

Magnetite occurs in the Tarryall Creek drainage basin and at the head of Beaver Creek in T. 8 S., R. 77 W., sixth principal meridian (location 78, fig. 1). The magnetite in the district is associated with gold and silver and was noted when prospected for those metals.

Magnetite, with garnet, epidote, actinolite, chlorite, calcite, quartz, some hematite, limonite, pyrite, pyrrhotite, occasional chalcopyrite, and gold and silver, occurs as small, separated, and irregular masses in thin, metamorphosed limestone and shale beds (Permian-Pennsylvanian) associated

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with Tertiary(?) intrusives. The deposits appear to be of contact-metamorphic origin. Magnetite also occurs in the beds of Tarryall Creek and its tributaries in sizes ranging from cobbles to sand.

A character sample of magnetite was taken by the Bureau of Mines October 11, 1957. It represented ore from a series of pits dug along a poorly exposed outcrop above timberline on the west slope of North Tarryall Creek in section 2, about 7-1/2 miles northwest of Como. The sample contained 51.4 percent iron, 0.08 percent phosphorus, 0.07 percent sulfur, 14.6 percent silica, and 0.1 percent manganese.

A spectrographic analysis shows 0.001-0.01 percent copper, gallium, indium, lead, zirconium, and chromium; 0.01-0.1 percent titanium, cobalt, and nickel; and 0.1-1.0 percent manganese.

A sample of impure magnetite representing the ore in the Beaver Creek Iron mine at the head of Beaver Creek, in secs. 16 and 17, contained 46.7 percent iron, 0.09 percent phosphorus, 3.87 percent sulfur, 19.2 percent silica, and 0.1 percent manganese.

The sample was taken by the Bureau of Mines October 11, 1957.

The ore had been used locally as a nonferrous smelter flux.

All mine workings in the area are inaccessible, but magnetite is common and can be found in many mine and prospect dumps near the head of Little French and Montgomery Gulches. A 2- to 4-foot-thick magnetite zone at the head of Montgomery Gulch was prospected extensively but finally was abandoned. Magnetite was noted on the Ute mine dump in section 10 and at the Link mine in section 15. The magnetite deposits are small and are not considered to be a commercial source of iron ore.

References: (43, pp. 109-116; 60, 64 pp.; 73, 44 pp).

Handcart Gulch-Hall Valley Limonite

Limonite occurs as a variety of yellow, red, and brown hydrous iron oxides in bog deposits on the patented Titania Placer (survey 2178) and on other claims staked recently along Hall Valley and Handcart Gulch in secs. 13 and 24, T. 6 S., R. 76 W., and secs. 19, 30, 31-33, T. 6 S., R. 75 W., sixth principal meridian, Halls Gulch mining district (location 79, fig. 1). The Titania placer claim is owned by V. J. Chandler et al., 2317 Clay Street, Denver, Colo.

The deposits (fig. 11) are almost continuously exposed along County Highway No. 221 and the North Fork of the South Platte River and Handcart Creek. They start about 4 miles west of Webster, extend up Hall Valley to its confluence with Handcart Creek, and continue northwesterly up Handcart Gulch to Red Cone Peak and Webster Pass. The limonite deposits are approximately 100 feet wide and up to 6 feet thick - and may prove to be larger in places.

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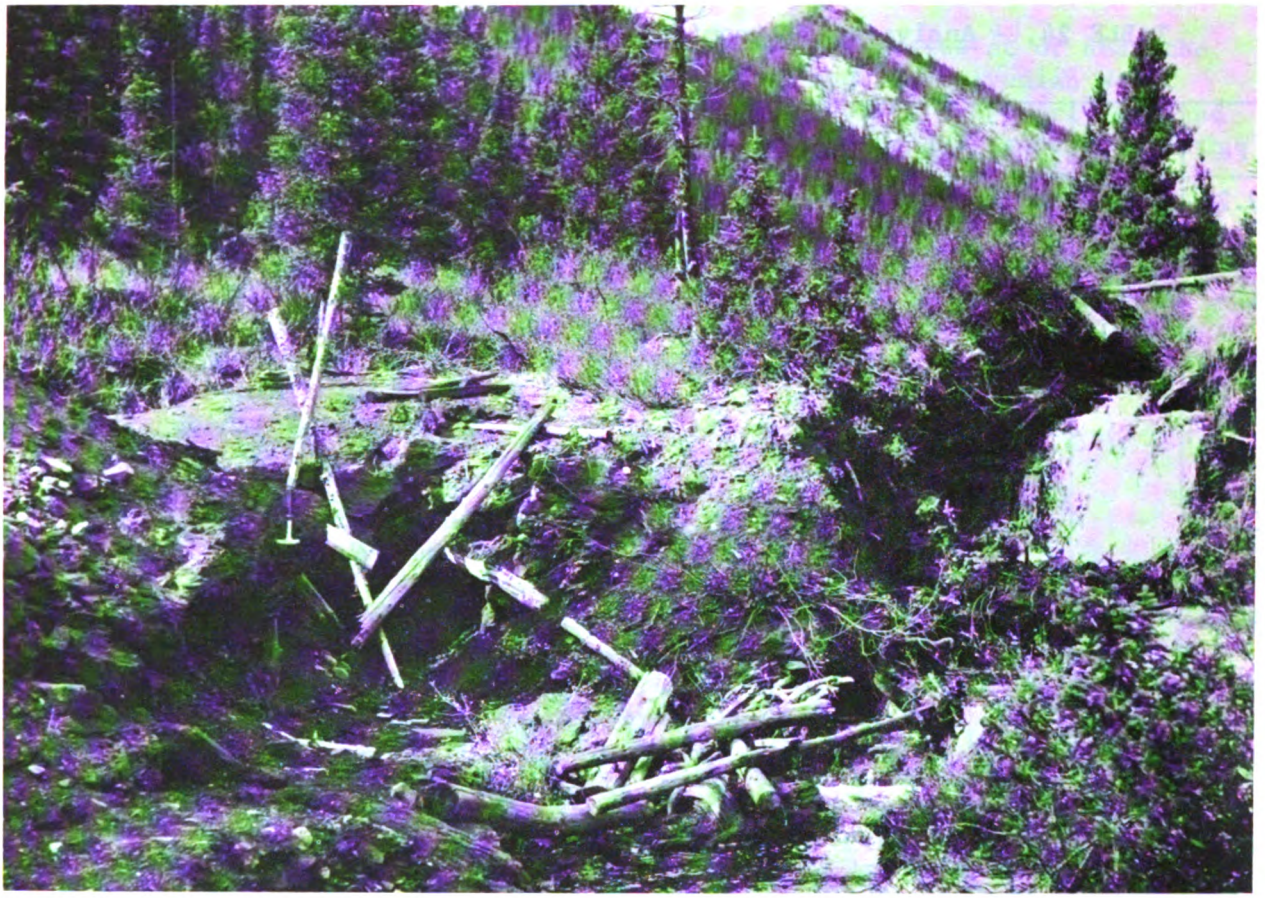

FIGURE 11. - Old Workings and Limonite in Creek Bed Near Head of Handcart Gulch, Park County, Colo.

The deposits vary in composition, texture, and iron content and are still being formed. They run from dry, well-consolidated, porous-to-hard, and almost pure limonite to loose, unconsolidated, mushy-to-firm mixtures of limonite, bog material, sand, and gravel. Limonite also coats and cements small fragments of slide rock. The better limonite deposits are upstream in Handcart Gulch. The iron is taken into solution where ground waters pass over the oxidizing, pyritic wash of Red Cone Mountain and is precipitated as limonite, goethite, turgite, etc., in the swampy creek bottoms.

The deposits are similar to those in the Snake River drainage basin in Summit County. Following are assays of the limonite reported from various sources.

Spectrographic analyses show 0.001-0.01 percent gallium, zirconium, and chromium; 0.001-1.0 percent lead and titanium; and 0.01-0.1 percent copper and manganese.

Two shallow cuts in Handcart Gulch and a few small pits in the bog-iron and gravel mixture in Hall Valley are the only accessible workings in the deposits.

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TABLE 24. - Analyses of limonite from Handcart Gulch-Hall Valley deposits (percent)

Fe	P	S	SiO_2	Mn	Loss on ignition	Al_2O_3	CaO	Remarks
29.2	0.11	0.69	33.4	<0.1	14.5	-	-	Character sample by the Bureau of Mines 10/11/57, Hall Valley bog iron, secs. 32-33, T. 6 S., R. 75 W.
44.3	.05	1.55	11.8	.2	21.5	-	-	Character sample by the Bureau of Mines 10/11/57, Handcart Gulch bog iron, in secs. 13 and 24, T. 6 S., R. 76 W.
65.1	-	-	7.0	-	-	0.5	-	Burnt ore charged into Hall Valley smelter (1875).
44.45	.397	-	7.18	-	23.59	-	1.22	Raw ore used by Hall Valley smelter in 1875.
48.4	.056 to .50	-	10.83	.1	18.8	-	Nil	Titania placer up to 15 feet thick (1883).

The small production was used as nonferrous metallurgical flux at the Hall Valley smelter in 1875.

References: (10; 12, pp. 266-273; 52, p. 571; 57, pp. 25, 54; 64, p. 144; 68, pp. 267-273).

Miscellaneous Magnetites

Quartz monzonite gneiss near Geneva Park, in approximate T. 6 S., R. 74 W., (location 80, fig. 1), contains uncommonly large amounts of magnetite, titanite, ilmenite, apatite, zircon, and pyrite. Magnetite also is abundant in pegmatites in the gneiss and may comprise roughly one-third of the pegmatite masses, but they are too small and too low grade to be considered commercial sources of iron ore.

Reference: (75).

Pitkin County

Cooper Creek Magnetites

The Cooper Creek magnetite occurrences are approximately in unsurveyed secs. 18 and 19, T. 12 S., R. 84 W., sixth principal meridian, in the Columbia mining district, in the White River National Forest (location 81, fig. 1). The deposits are on public domain, near the head of Cooper Creek. They are about half a mile apart and on opposite sides of the creek. The deposits are at altitudes of about 10,000 feet and access is difficult by trails from Ashcroft.

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The magnetite occurs as small replacement-type deposits at or near the contact between Mississippian Leadville limestone and Pennsylvanian Weber formation and Tertiary dioritic intrusives. The deposits are poorly exposed and appear as black magnetite partly altered to limonite and associated with pyrite. Reserves appear to be small and are not considered a commercial source of iron ore.

Coopers Fork Creek Magnetite

The Coopers Fork Creek magnetite deposit (fig. 12) is in the Columbia mining district, in unsurveyed secs. 16 and 17, T. 12 S., R. 84 W., sixth

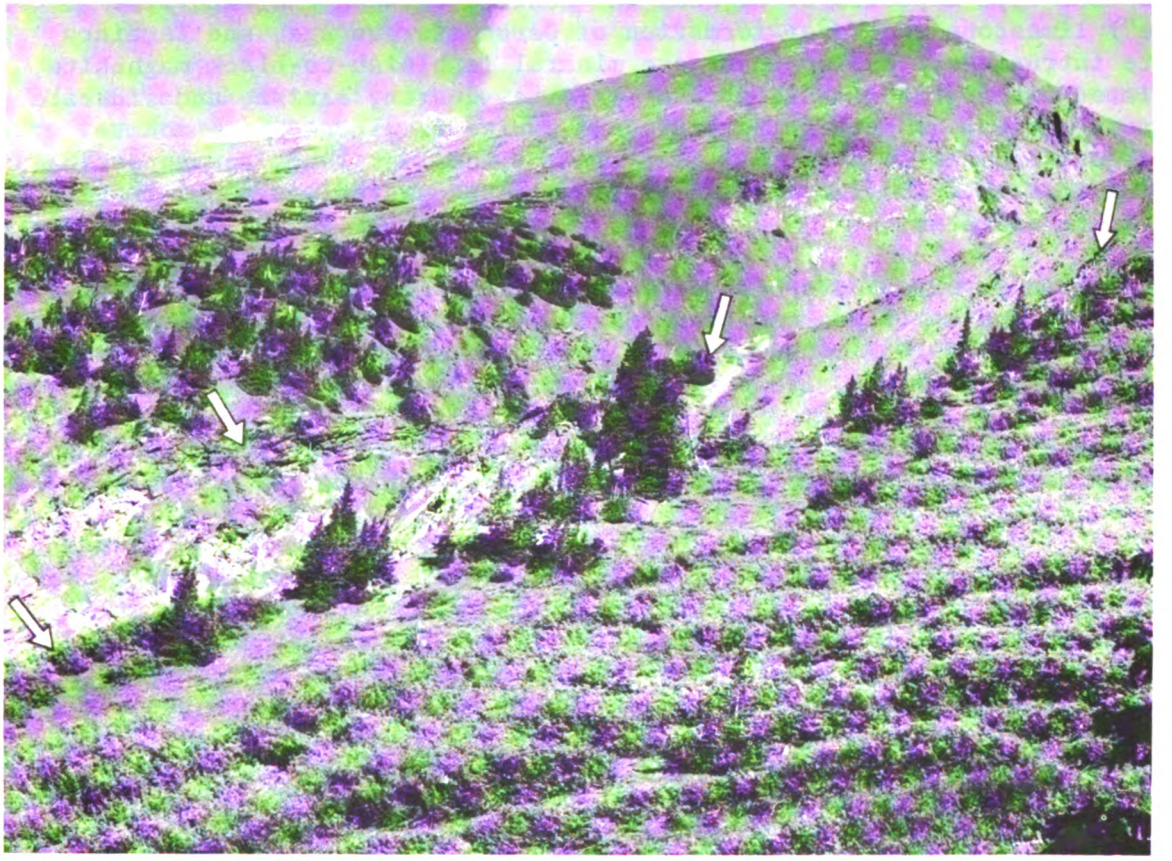

FIGURE 12. - Coopers Fork Magnetite Deposit, Pitkin County, Colo. Arrows point to magnetite outcrops.

principal meridian. It is about 3-1/4 miles S. 14° E. of Ashcroft and on the northwest slope of Taylor Peak in the Elk Mountains. It is near the head of Coopers Fork Creek at an altitude of approximately 12,000 feet (location 82, fig. 1). The deposit is reached by traveling 2.7 miles south from Ashcroft, over a road that parallels Castle Creek, then fording Castle Creek, and following partly obliterated trails for about 2 miles in a general east-southeast direction along Coopers Fork to the property. The deposit is covered by a group of 10 patented mining claims: Iron Mountain Boy,

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Iron King, Fall River, Star, Hidden Treasure, Mammoth, Cincinnati (survey 4377) and Iron Point (3943), Iron (3955) and Castle Creek placer (4430). The surface, and the mineral rights, other than coal and oil, are owned by Robert S. Killey, Los Angeles, Calif., and are leased to Rees Llewellyn of Glenwood Springs, Colo.

The property was known before 1885 and has been referred to as the old Colorado Fuel and Iron Co. mine, the Cooper iron mine, and the Taylor Peak iron deposit. Apparently the only production consisted of small trial shipments.

One large and two smaller deposits of magnetite occur as irregular replacement-type deposits at or near the contact between the Leadville ("Blue") limestone and Weber formation of Carboniferous age, and Tertiary diorite intrusives. The dominant ore mineral is bluish-to-black magnetite, associated with pyrite, chalcopyrite, calcite, quartz, barite, and siderite. In places a minor amount of magnetite and pyrite is altered to limonite. The largest deposit is about 800 feet wide, 1,200 feet long, and reported as being more than 100 feet thick. The smaller deposits are approximately 250 feet in diameter.

Iron-ore reserves have been estimated by the Federal Geological Survey at between 3 and 4 million tons and possibly more. A sample taken by the Bureau of Mines in 1957 contained 67.2 percent iron, 0.02 percent phosphorus, 0.63 percent sulfur, 1.8 percent silica, and 0.3 percent manganese.

A spectrographic analysis shows 0.001-0.01 percent gallium, lead, zirconium, and chromium; 0.01-0.1 percent copper, titanium, and cobalt; and 0.1-1.0 percent manganese.

The workings on the deposit consist of several inaccessible adits that are reported as being up to 120 feet long and ending in limestone. It is unknown whether the limestone in the adits is a block contained in the magnetite or the wall in place. Further exploration would be required to determine this and the true thickness of the deposit.

References: (2, p. 37; 11, p. 123; 12, p. 272; 31, pp. 638-640; 41, p. 188-194; 44, pp. 101-102).

Miscellaneous Iron Occurrences

Magnetite of unknown extent occurs on Avalanche Creek, in approximate sec. 28, T. 10 S., R. 87 W., sixth principal meridian, in the Avalanche mining district (location 83, fig. 1). It reportedly contains 56 percent iron and is free of titanium and phosphorus.

Reference: (15, pp. 28-29).

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Pueblo County

Overton-Steele Hollow Limonite-Siderite

A bed containing concretions of limonite and siderite, with clay, is exposed north-northwest of Pueblo on the slope between Baculite Mesa and the Arkansas River. It extends past Overton and Steele Hollow (location 84, fig. 1) and is in the Rusty zone of the Cretaceous Pierre formation. The concretions were at one time mixed with other iron ores and smelted at Pueblo. Overton is about 7 miles north of Pueblo.

Reference: (39, p. 6).

South of Pueblo, Limonite-Siderite

Near the Arkansas River below Pueblo, the Rusty zone of the Cretaceous Pierre formation is approximately 600 feet thick and contains abundant concretions of gray siderite, 4 to 6 inches thick and 1 to 2 feet long. They weather out of the enclosing gray shale as the rust-colored, limonitic fragments that give the zone its name.

Concretions of limonite-siderite (carbonaceous or kidney ore) were mined south of Pueblo, (location 85, fig. 1) and used in foundry-iron mixes. The ore averaged 22-32 percent iron and 11-17 percent siliceous matter and was high in lime and phosphorus.

Small deposits of hematite reportedly occur as cavern filling west of Beulah, in approximate T. 23 S., R. 68 W., sixth principal meridian.

Reference: (6, p. 53; 68, pp. 266-273).

Saguache County

Alder Limonite

Limonite occurs 2 road miles east of Alder, between branches of Decker Creek, in sec. 29, T. 48 N., R. 9 E., New Mexico principal meridian (location 87, fig. 1). The property (fig. 13) also is known as the Miller, Round Hill, and Decker Creek deposit and is the property of Commercial Minerals, Inc., of Salida.

Yellow, red, and brown-to-black limonite is exposed in several outcrops trending northeasterly for about 800 feet along the north and south branches of Decker Creek. The deposit is about 100 feet wide and appears to be as much as 8 feet thick but may be thicker in places. It is of bog origin and varies in composition, texture, and iron content. Parts of the deposit are almost pure, porous, and clinkery limonite; part is a mixture of sand, gravel, and limonite; and part consists of angular-to-subangular fragments of schist, gneiss, and pegmatite, coated and cemented by limonite.

About 50 tons of the hand-sorted limonite ore was shipped to the Colorado Fuel and Iron Corp. in 1943. It assayed 45.0 percent iron. Assays of the ore from various sources are shown in table 25.

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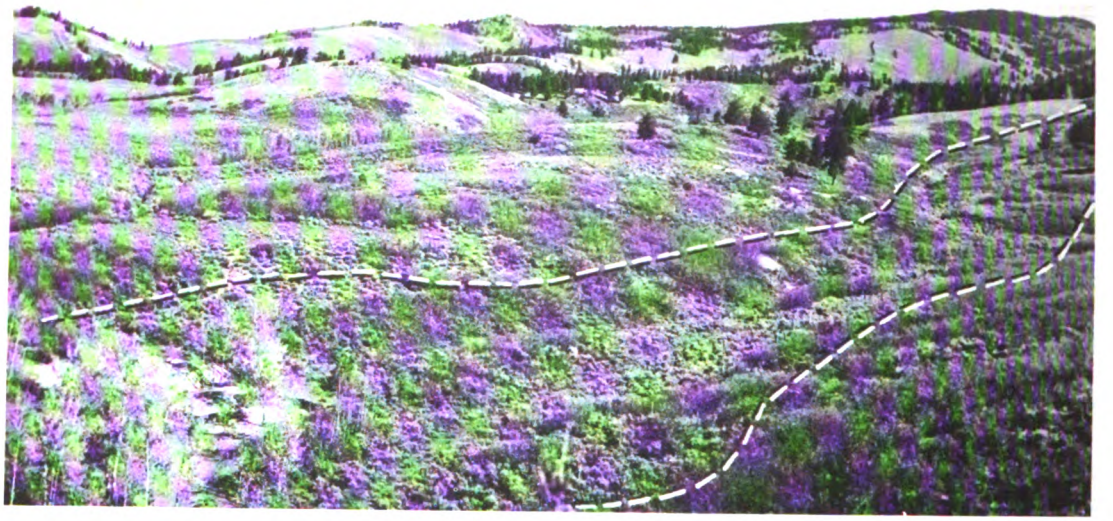

FIGURE 13. - Alder Limonite Deposit, Saguache County, Colo. Deposit is in creek channel as shown in outlined section.

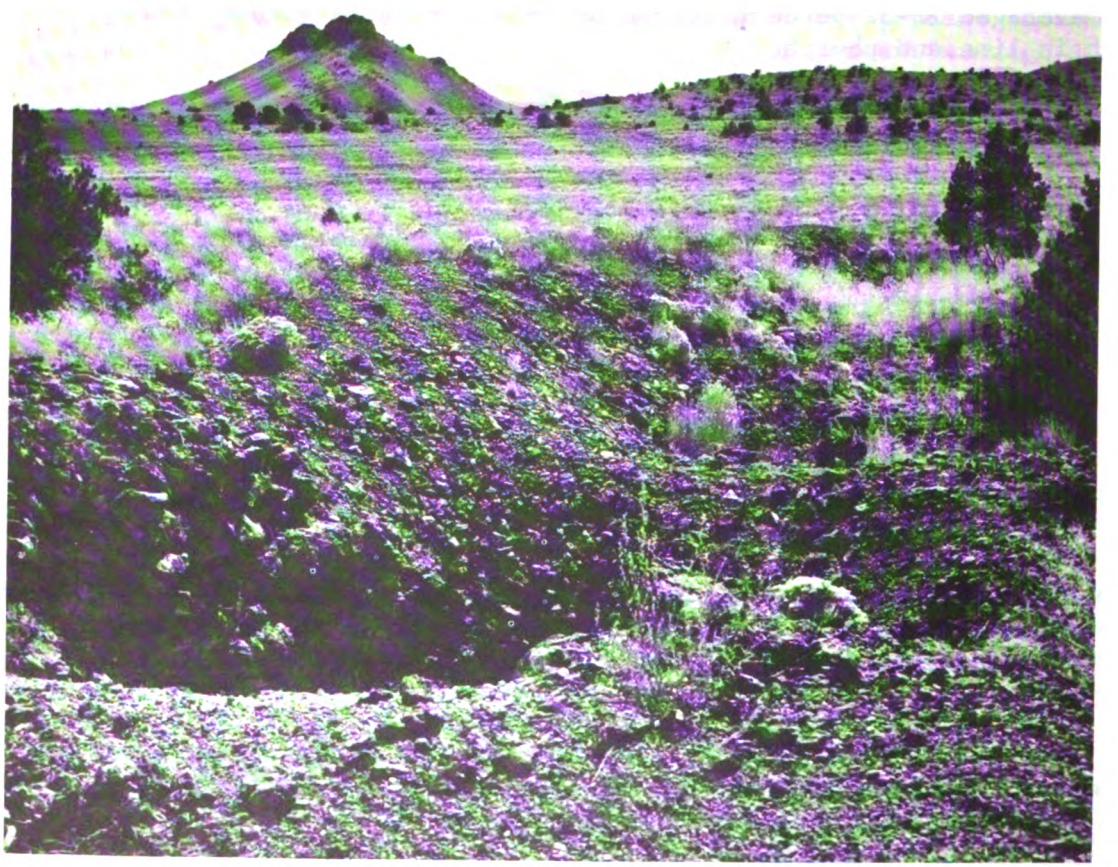

FIGURE 14. - Del Norte Limonite Deposit, Saguache County, Colo.

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TABLE 25. - Analyses of limonite from Alder deposit (percent)

Fe	P	S	SiO_2	Mn	Loss on ignition	Al_2O_3	MgO	Remarks
29.8	0.23	0.37	36.4	<0.1	10.6	-	-	Character sample of ore taken by Bureau of Mines, 9/20/57.
45.0	.032	-	19.9	-	-	3.5	0.3	Analyses of 50 tons sorted ore sent to Colorado Fuel & Iron Corp. (1943) by Commercial Minerals Corp. of Salida.

A spectrographic analysis shows 0.001-0.01 percent gallium, lead, zirconium, and vanadium; 0.01-0.1 percent copper, chromium, manganese, and nickel; and 0.1-1.0 percent titanium.

Workings on the deposit consist of several small cuts. The deposit is small and not a source of acceptable iron ore.

Reference: (Local inquiry).

Del Norte Limonite

Limonite bog iron (fig. 14) occurs in approximate sec. 30, T. 41 N., R. 6 E., New Mexico principal meridian, about 2-1/2 miles north-northwest of East Butte (location 88, fig. 1). The property, on public domain, is reached by driving 8 miles over poor ranch roads in a flat and arid valley.

The deposit is of bog origin and consists of hard, brown-to-black limonite exposed in nearly flat layers on a low ridge. It trends N. 60° W. for about 1,500 feet, is 250 feet wide and as much as 5 feet thick and perhaps more. The iron content is variable and depends on amounts of sand and rock fragments included. Some production reportedly was shipped to Pueblo before 1880, but this report could not be verified. A character sample taken by the Bureau of Mines October 7, 1957, assayed 47.8 percent iron, 0.23 percent phosphorus, 1.13 percent sulfur, 11.8 percent silica, and 0.1 percent manganese, and 14.5 percent was lost on ignition.

A spectrographic analysis shows 0.001-0.01 percent copper, gallium, lead, zirconium, and chromium; 0.01-0.1 percent vanadium and manganese; and 0.1-1.0 percent titanium.

The workings, which appear to have been long abandoned, consist of several small pits in the deposit and around it.

The deposit is too small and isolated to be considered a commercial source of iron ore.

Reference: (43, p. 112).

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Indian Creek Limonite

Deposits of limonite with some hematite occur along Indian Creek in the northwestern part of T. 48 N., R. 6 E., New Mexico principal meridian, about 8 miles east of Sargents up the Marshall Pass and Indian Creek roads (location 89, fig. 1). Limonite occurs in small, replacement-type deposits in Paleozoic Devonian(?) limestone and in small bog-iron deposits along Indian Creek. The largest deposit was observed in sections 17 and 18, on the Erie group of uranium claims located by Vulcan Silver-Lead Co., of Gunnison. A deposit of impure limonite having a maximum thickness of 10 feet is exposed along a road cut for about 200 feet. A character sample of the better grade limonite taken by the Bureau of Mines in 1957 assayed 42.6 percent iron, 0.07 percent phosphorus, 0.43 percent sulfur, 20.8 percent silica, and 0.1 percent manganese, and lost 14.3 percent on ignition.

A spectrographic analysis shows 0.001-0.01 percent gallium, lead, zirconium, and chromium, and 0.01-0.1 percent copper, titanium, manganese and nickel.

Reference: (26, p. 129).

Kerber Creek Limonite

Limonite occurs along Kerber Creek and the Bonanza road in approximate sec. 22, T. 46 N., R. 8 E., New Mexico principal meridian. The deposits are exposed along the road (location 90, fig. 1) 7.2 miles northwest of Villa Grove. There has been no production.

Yellow and reddish-to-brown limonite cements sand and cobbles and forms a breccia with angular to subangular fragments of limestone (fig. 15). In places the limonite is little more than a coating. A sample of the better limonitic material taken by the Bureau of Mines October 8, 1957, ran 24.2 percent iron, 0.11 percent phosphorus, 0.34 percent sulfur, 48.6 percent silica, 0.4 percent manganese, and 6.8 percent loss on ignition.

A spectrographic analysis shows 0.001-0.01 percent copper, gallium, zirconium, chromium, and molybdenum; 0.01-0.1 percent lead, cobalt, and nickel; and 0.1-1.0 percent titanium and manganese.

A nearly horizontal deposit of limonitic material is exposed in a road cut for a length of about 350 feet, a width of about 50 feet, and in thicknesses up to 7 feet and perhaps more. It is too low grade to be of commercial value.

Reference: (43, p. 112).

Major Creek Limonite Mine

The Major Creek mine (fig. 16), also known as the Moffat and Bennett mine, is on Major Creek in sec. 8, T. 45 N., R. 11 E., New Mexico principal meridian (location 91, fig. 1). It is about 3 miles southeast of the Orient mine in the Blake mining district and Rio Grande National Forest. The mine

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is reached by driving 13.5 miles southeast from Villa Grove to Major Creek and then 1-1/2 miles up Major Creek. The deposit is covered by the Major No. 1 claim, staked in 1956, and the Moffat No. 1 claim, staked March 24, 1957. The claims are owned by Charles F. Jones and Tom Benton of Villa Grove. There is no record of ore production from these claims.

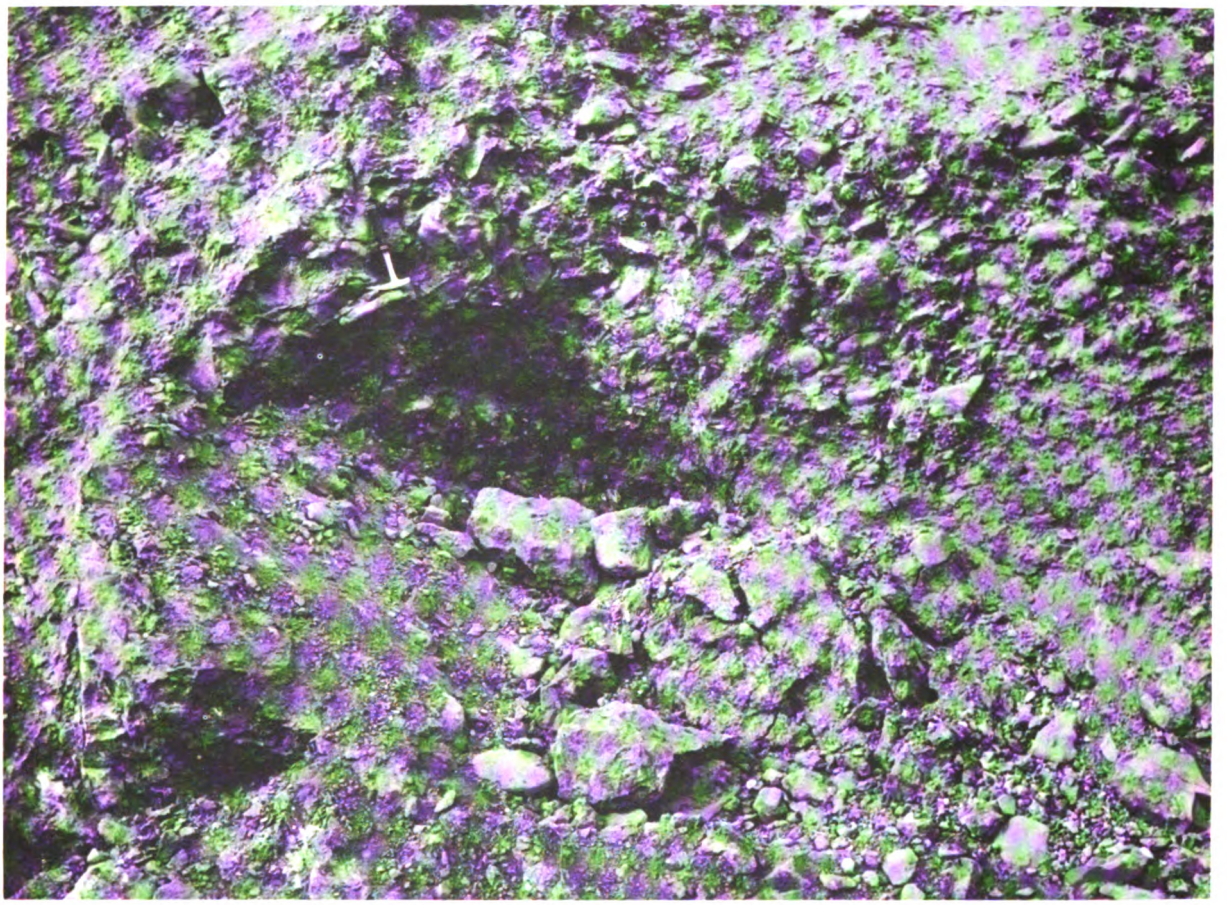

FIGURE 15. - Kerber Creek Limonite Exposure Along Villa Grove-Bonanza Road, Saguache County, Colo.

A character sample of the better grade ore taken by the Bureau of Mines October 8, 1957, contained 53.7 percent iron, 0.17 percent phosphorus, 1.53 percent sulfur, 8.6 percent silica, and 0.1 percent manganese and lost 12.1 percent on ignition.

A spectrographic analysis shows 0.001-0.01 percent gallium, zirconium, and chromium; 0.01-0.1 percent lead, titanium, manganese, cobalt, and nickel; and 0.1-1.0 percent arsenic.

Workings on the property consist of several small cuts, two caved upper adits, and a 70-foot-long lower adit, bearing N. 62° W., which was partly accessible.

Reference: (43, p. 112).

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FIGURE 16. - Major Creek Limonite Deposit, Saguache County, Colo. Arrows point to old workings and outcrops.

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Orient Limonite-Hematite Mine

The Orient deposit, discovered about 1880, was operated until 1931 by The Colorado Fuel and Iron Corp. About 1,700,000 tons of ore was produced. The property is still owned by the corporation and comprises the following claims in sec. 25, T. 46 N., R. 10 E., Blake mining district (location 92, fig. 1):

Anna Lee	Grand Tower	Portia
Beehive	Grand View	Prospector
Booth	Hamlet	Runaway
Brutus	Ironton	Security Placer
Caesar	Macbeth	Top Gallant
Cleopatra	McClelland	Trilby
D. W. Jones	Mercutio	Valley View
Enterprise	Nero	Villa Grove
Ephemeris	Othello	Vivia B
Flag	Poormans	West Virginia

The claims are along the west flank of the Sangre de Cristo Mountains (fig. 17), at an altitude of about 9,000 feet, and are readily accessible the year round over Federal and State highways and a short secondary road. The deposit is about 8 miles southeast of Villa Grove, 23 miles by road northeast of Saguache, and just north of the now-abandoned Valley View hot springs resort.

The ore consists of porous-to-clinkery limonite with some massive red and flaky specular hematite and ochre occurring as irregular masses, lenses, and pipes. The ore grades into lean material consisting of limestone partly replaced by limonite and hematite, siderite, ochre, and brown-stained limestone. Impurities noted are quartz, calcite, barite, chalcopyrite, and oxidized copper minerals. The ore is believed to have resulted from the oxidation of replacement-type bodies of iron-bearing carbonate in the lower part of the Mississippian Leadville (Blue) limestone. Ore has been developed over a vertical range of 1,000 feet.

All equipment was removed long ago, and the underground workings are inaccessible. The character of the ore can be observed in the dumps and in many cuts on the property.

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FIGURE 17. - Orient Mine, Saguache County, Colo. Mine dumps in background.

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Analyses of the ore reported from various souces are as follows:

TABLE 26. - Analyses of ore from Orient mine (percent)

Fe	P	S	SiO_2	Mn	Al_2O_3	CaO	MgO	Loss on ignition	Moisture	Remarks
43.3	0.026	0.06	7.87	1.43	0.92	1.92	0.61	10.17	12.30	Average of ore.
40.1	.01	.36	11.8	.5	-	-	-	16.0	-	Bureau of Mines character sample of ore exposed in pits, 1957.
54.47	.026	-	-	-	-	-	-	-	-	Beehive lode.
55.56	.058	-	-	-	-	-	-	-	-	Prospector lode.
51.64	.055	-	-	-	-	-	-	-	-	Poormans lode.
55.61	.034	-	-	-	-	-	-	-	-	McClelland lode.
45.39	.045	-	-	-	-	-	-	-	-	Saguache lode.
59.6	-	-	3.6	.65	-	1.0	-	-	-	High-grade ore in diamond drill hole.
26.0 to 31.7	-	-	33.6 to 38.7	-	-	-	-	-	-	Three samples of yellow ochre.

A spectrographic analysis shows 0.001-0.01 percent gallium, lead, titanium, zirconium, and chromium; 0.01-0.1 percent cobalt and nickel; and 0.1-1.0 percent copper and manganese.

Large tonnages of ocherous material and low-grade ore remain in extensive dumps and in the walls of open pits, and significant ore reserves reportedly remain underground.

References: (8, pp. 13-24; 11, pp. 124-125; 62, pp. 414-415; 66, pp. 472-485; 68, pp. 266-273; 76, pp. 317-329; 77, pp. 144-145.

San Juan County

Burro Bridge Limonite

Limonite occurs near Burro Bridge, 1-1/2 miles south of Chattanooga, just west of U.S. Highway No. 550 and Mineral Creek. The deposit is approximately in unsurveyed secs. 2 and 3, T. 41 N., R. 8 W., New Mexico principal meridian, at an altitude of about 9,800 feet (location 93, fig. 1). It was known before 1882, but there has been no production from it. The spring-type deposit is a fan-shaped apron of limonite mixed with surface debris extending downhill to Mineral Creek. Along Mineral Creek small bog deposits occur in the swampy portions of the streambed. The deposits are similar in character and approximate size to those in the vicinity of Chattanooga.

Workings consist only of a few old and sloughed-in shallow pits.

References: (17, p. 190, map; 24, p. 33; 67, p. 113).

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Cement Creek Bog Limonite

Limonite bog iron occurs along Cement Creek in unsurveyed secs. 19, 20, 30 and 31, T. 42 N., R. 7 W., and in sec. 6, T. 41 N., R. 7 W., Eureka (Cement Creek) mining district, north of Silverton (location 94, fig. 1). The deposits are visible along the Cement Creek road.

Small, separate deposits of limonite are found along Cement Creek in a 4-mile stretch of swampy areas that starts just south of Gladstone. The limonite occurs as coatings and cement of gravel or as mushy masses of bog debris (wood, moss, grass, etc.). The deposits are formed of the hydrous iron oxides limonite, goethite, and turgite precipitated along creek channels from ground waters that have dissolved iron from sulfide-bearing rocks and veins. At present limonite is being actively deposited. The deposits are too small and low grade to be considered sources of iron ore. The limonitic bogs are 500 to 1,000 feet long, 25 to 300 feet wide, thin, and low grade. They have not been exploited.

Chattanooga Limonite

Limonite occurs on Red Dust claims 1 to 3 (fig. 18) and the Hope lode in unsurveyed sec. 34, T. 42 N., R. 8 W., New Mexico principal meridian, at 9,800 feet altitude (location 93, fig. 1). The deposits are about 0.7 mile south of Chattanooga and just west of U.S. Highway No. 550 and Mineral Creek. The claims were located in 1956 by Paul V. Boyd of Ouray. The deposits were known before 1882, but no ore has been produced from them.

The main deposit consists of spring-type limonite; it is triangular with the apex at the spring and fans out downhill to Mineral Creek. It consists of soft, loose, yellow-to-orange, and reddish-brown limonite containing fragments of sound wood and talus. The deposit has a downhill length of about 575 feet, a base width of 300 feet and is 3 to more than 10 feet thick. The limonite is exposed at the spring opening, in a cut beside the spring, and in two cuts about 50 and 100 feet above Mineral Creek. Smaller bog-iron deposits occur along Mineral Creek, below the main spring deposit, and in the swampy parts of Mineral Creek. A character sample of the deposit taken by the Bureau of Mines October 5, 1957, assayed 42.8 percent iron, 0.04 percent phosphorus, 0.71 percent sulfur, 9.4 percent silica, and 4.9 percent manganese, and lost 18.9 percent on ignition.

A spectrographic analysis shows 0.001-0.01 percent copper, gallium, and zirconium; 0.01-0.1 percent lead, titanium, and cobalt; and 1.0-10.0 percent manganese.

Workings on the property consist of an old, partly sloughed-in pit next to the spring and two recently dug road cuts across the deposit.

References: (17, p. 190, map; 24, p. 33; 67, p. 113).

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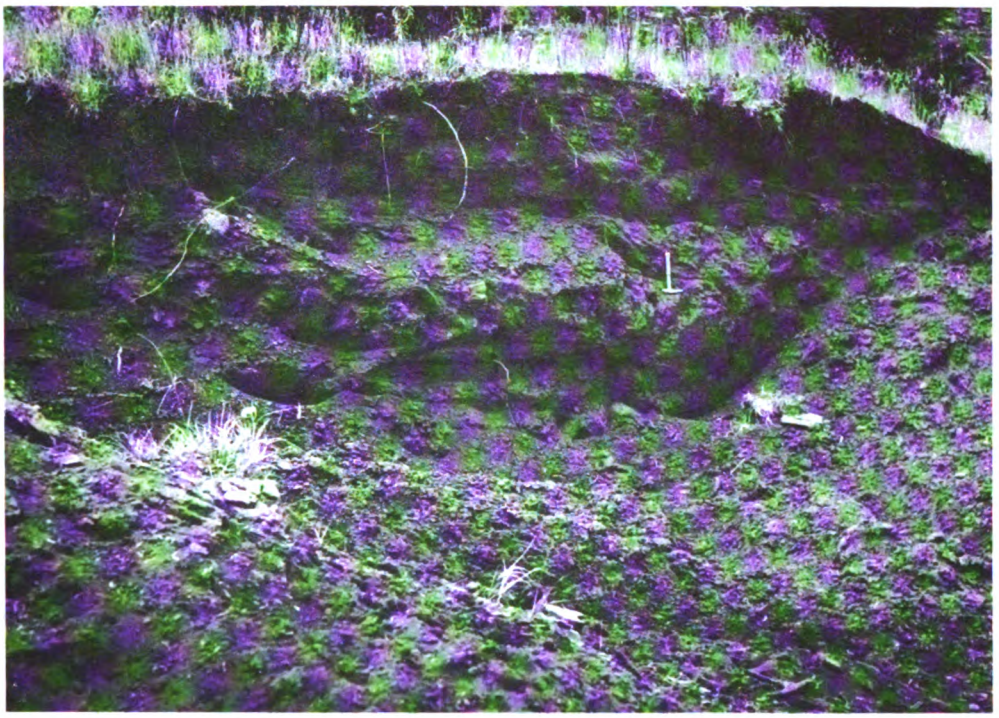

FIGURE 18. - Chattanooga Limonite Deposit, San Juan County, Colo.

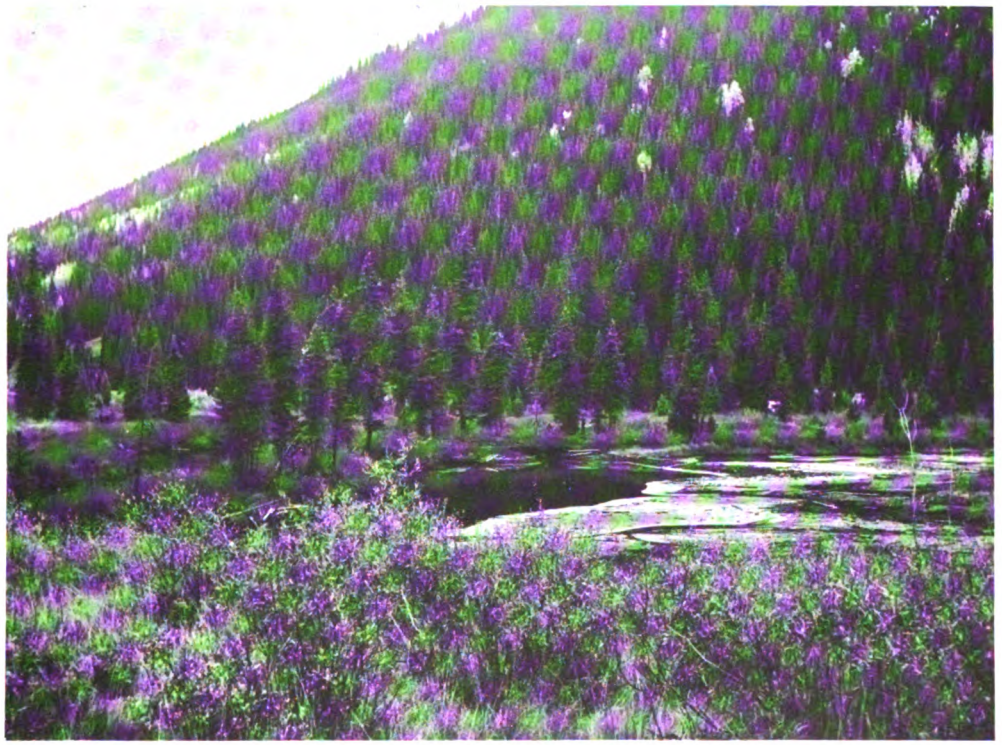

FIGURE 19. - Mineral Creek Bog Iron Deposit Near Silverton, San Juan County, Colo.

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Mineral Creek Limonite

Limonite bog iron (fig. 19) occurs along the drainage of Mineral Creek, at an altitude of 9,500 feet, in unsurveyed sec. 15, T. 41 N., R. 8 W., New Mexico principal meridian, 1.2 miles west of the intersection of Mineral Creek and U.S. Highway No. 550 (location 95, fig. 1). The property is owned by San Juan County. A small production is reported; it was used as nonferrous smelter flux in the late 1800's.

Yellow-to-reddish-brown limonite is being deposited for about 0.3 mile of swampy area along Mineral Creek. The bog ore varies greatly in composition and iron content, from a fine-grained, unconsolidated limonite, to a poorly consolidated limonite-and-gravel mixture, or a mushy mass of limonite, peat moss, and other plant remains. The better part of the limonitic bog is about 200 feet long by 175 feet wide and at least 3 feet thick.

A character sample of the better bog limonite taken by the Bureau of Mines October 5, 1957, assayed 48.4 percent iron, 0.03 percent phosphorus, 2.03 percent sulfur, 5 percent silica, and less than 0.1 percent manganese and lost 23.7 percent on ignition.

A spectrographic analysis shows 0.001-0.01 percent copper, gallium, lead, and zirconium and 0.01-0.1 percent titanium and manganese.

Workings on the property consist of several shallow, water-filled pits from which the better bog iron probably was mined and used locally for nonferrous smelter flux. The deposit is too small and low grade to be considered a commercial source of iron ore.

References: (17, p. 190, map; 24, pp. 33-34; 27, p. 9).

Silverton Reservoir Limonite

Limonite occurs at the Silverton reservoir (fig. 20), at an altitude of 9,500 feet. It is in approximate secs. 16 and 17, of unsurveyed T. 41 N., R. 7 W., New Mexico principal meridian, on the south slope of Storm Peak, just northeast of Silverton (location 96, fig. 1). It is owned by the city of Silverton.

Yellow-to-brown and reddish limonite occurs in a bed, cementing gravel, shale, and fragments of wood that have been partly replaced by limonite. The deposit crops out above and along the road between the Silverton reservoir and the cemetery. It is about 650 feet long (N.-S.), 500 feet wide (E.-W.), and up to 6 feet thick or perhaps more. The deposit trends southwesterly downhill and still is being formed.

The presence of old magnetic slag indicates that the deposit was the former site of a nonferrous smelter and that some of the deposit may have been used as a smelter flux. A character sample of the ore taken by the Bureau of Mines October 5, 1957, assayed 50.5 percent iron, 0.11 percent phosphorus, 1.04 percent sulfur, 6.2 percent silica, and less than 0.1 percent manganese, and lost 18.6 percent on ignition.

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FIGURE 20. - Silverton Reservoir Limonite Deposit, Silverton, San Juan County, Colo. Arrows indicate approximate width of outcrop.

A spectrographic analysis shows 0.001-0.01 percent lead and zirconium, and 0.01-0.1 percent copper and titanium.

Reference: (Local inquiry).

Miscellaneous Iron Occurrences

Silverton Area

Excavation along the lower reaches of Mineral Creek just west of Silverton, at the old Comstock Sampling Works, revealed a deposit of gravel, coated and cemented with limonite and reportedly covered by 3 to 100 feet of alluvium. Another limonite deposit occurs in the bed of Mineral Creek and is known as the Iron Placer. Both are in the general vicinity of location 85 on figure 1.

The deposits are too low grade to be considered a commercial source of iron ore. Some production was used locally as nonferrous smelter flux.

Reference: (17, map and p. 190).

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San Miguel County

Chapman Gulch Limonite

Limonite bog iron occurs just east of Chapman Gulch, sec. 36, T. 42 N., R. 9 W., New Mexico principal meridian, Ophir (Iron Springs) mining district. It is 2.6 miles east of the Old Ophir cemetery, along the Ophir Pass road, at an altitude of 10,500 feet (location 97, fig. 1). There has been no production from the deposit.

Yellow and reddish-to-brown limonite is spread over an area about 600 feet long (N.-S.), 55-150 feet wide (E.-W.), and up to 6 feet or more thick. The deposit slopes downhill towards Howards Fork Creek. The limonite is of spring and bog origin and still is forming. Iron is taken into solution by meteoric waters passing through iron sulfide-bearing rocks and veins above. The waters issue from the steep hillsides as ferruginous springs. Limonite is deposited at their orifices and in the marshy creek bottom below. A character sample of the ore, taken by the Bureau of Mines October 4, 1957, assays 46.5 percent iron, 0.02 percent phosphorus, 1.77 percent sulfur, 3.4 percent silica, less than 0.1 percent manganese, and 27.7 percent loss on ignition.

The deposit is exposed in a road cut for 55 feet and is more than 5 feet thick. About 500 feet farther downhill it is exposed in another cut for 130 feet and is 6 feet or more thick. Overburden is up to 1 foot thick. The deposit is just east of the Iron Springs deposit and similar to it.

Reference: (27, p. 9).

Ferric Oxide Limonite

Bog limonite occurs on the Ferric Oxide lode claim (fig. 21) on the north side of Howards Fork Creek, in sec. 36, T. 42 N., R. 9 W., New Mexico principal meridian, Ophir (Iron Springs) mining district. The property is 1 mile by road, east of Old Ophir cemetery on the Ophir Pass road, at an altitude of about 10,000 feet, and is just west of the Iron Springs deposit (location 97, fig. 1). It belongs to R. Belisle, of Ophir. A small production was used as an ingredient in a soil conditioner.

The deposit is of spring and bog origin and consists of lightweight, mushy-to-well-consolidated, porous, yellow-to-brown limonite, peat moss, and bog debris. It trends southerly, from its origin at the spring, down a drainage of the steeply sloping side of San Joaquin Ridge to Howards Fork Creek and is visible in the bog bottom of the creek. Iron is taken into solution by meteoric waters passing through iron-sulfide-bearing rocks and veins above. The water issues from the steep hillside as one or more ferruginous springs. Limonite is deposited around their orifices, on the swampy slopes, and in the creek bottom. It is still in process of formation. A character sample of the ore taken by the Bureau of Mines October 4, 1957, assayed 46.5 percent iron, 0.02 percent phosphorus, 1.77 percent sulfur, 3.4 percent silica, and less than 0.1 percent manganese, and lost 27.7 percent of ignition.

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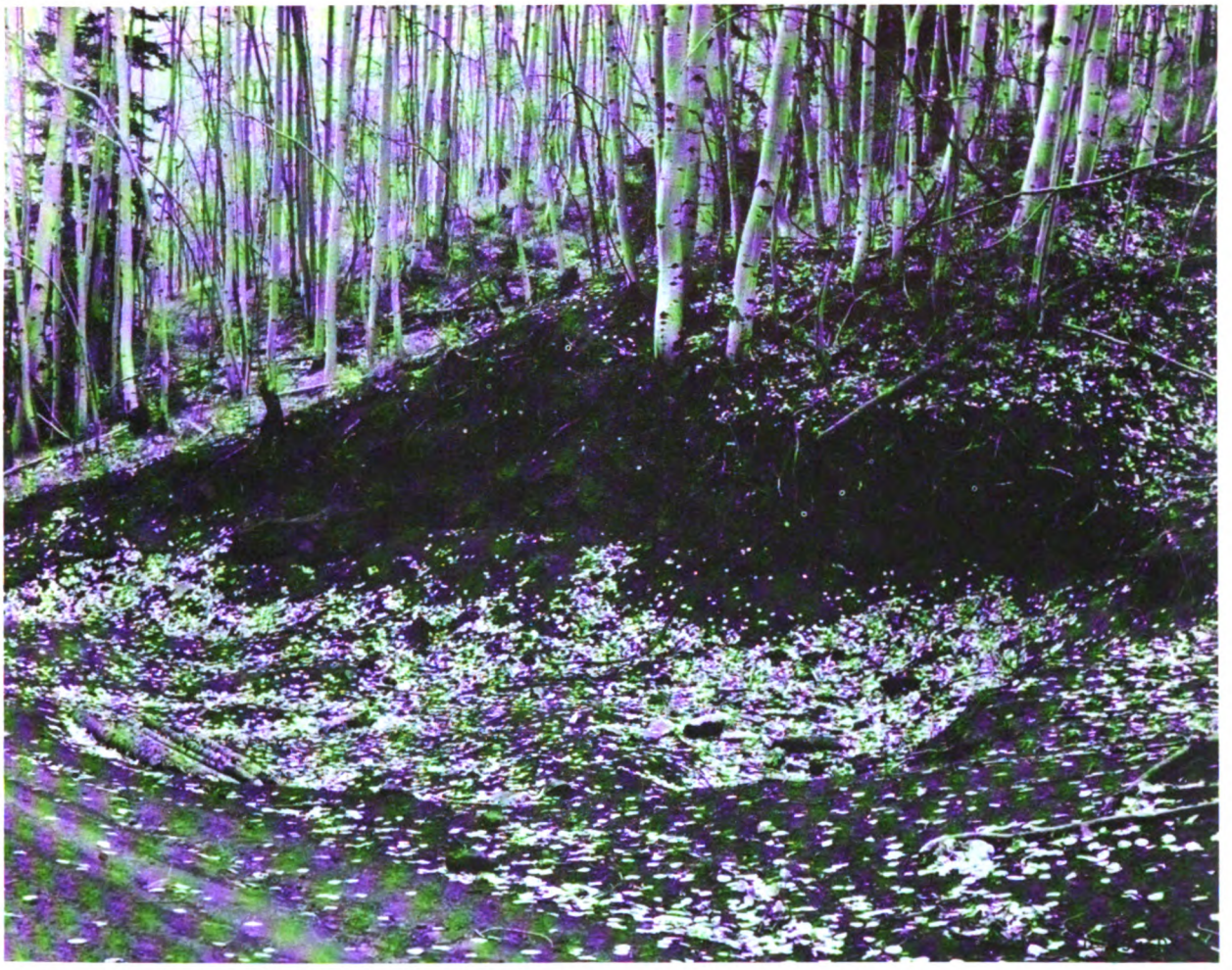

FIGURE 21. - Limonite Outcrop, Ferric Oxide Claim, Old Ophir, San Miguel County, Colo.

A spectrographic analysis shows 0.001-0.01 percent titanium and zirconium, and 0.01-0.1 percent copper, lead, and manganese.

The ore is exposed in three cuts - two above and one below the Ophir Pass road. It is covered by as much as 10 feet of peat moss and bog debris, and near the Howards Fork Creek channel it is partly covered by old mill tailings. The deposit is about 900 feet long (E.-W.) by 300 feet wide (N.-S.). Its thickness is unknown, but it is probably 10 feet or more thick.

Reference: (27, p. 9).

Iron Springs Limonite

Limonite bog iron occurs on the 160-acre Iron Springs placer claim (fig. 22) in sec. 36, T. 42 N., R. 9 W., New Mexico principal meridian, Ophir (Iron Springs) mining district, at an altitude of about 10,500 feet. It is 1.7 miles east of the Old Ophir cemetery on the Ophir Pass road and lies along Howards Fork Creek between the Ferric Oxide and Chapman Gulch deposits (location 97, fig. 1).

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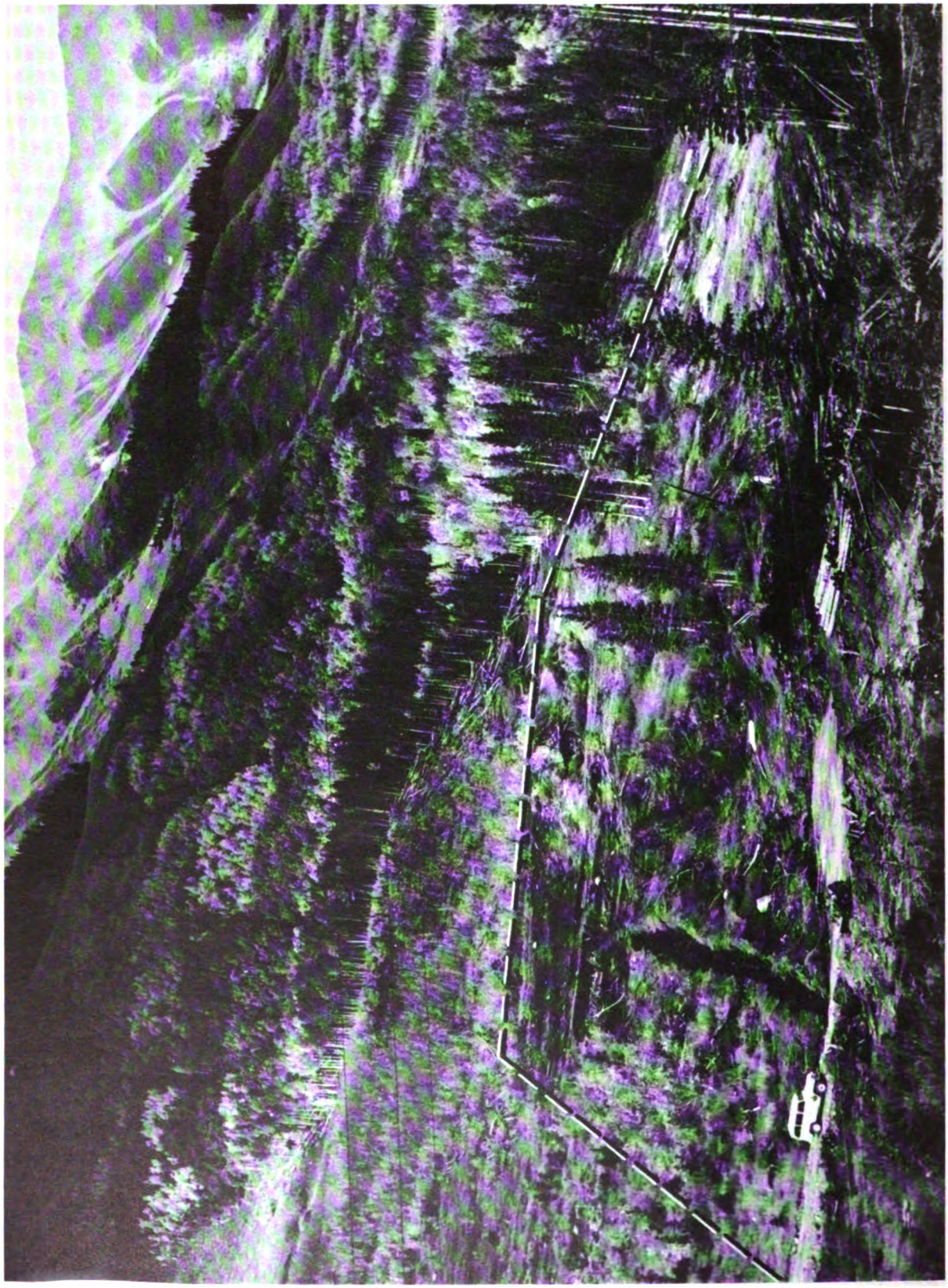

FIGURE 22. - Iron Springs Limonite Deposit, Old Ophir, San Miguel County, Colo.

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Yellow and reddish-to-brown limonite occurs as a well-consolidated deposit, more than 1,500 feet long (N.-S.), 600 to 800 feet wide, and 6 to 15 feet or more thick. It extends about 1,500 feet downhill from the overflow of Iron Spring, after which the district was named. The deposit is of spring and bog origin and still is forming. Iron is taken into solution by ground water passing through iron sulfide-bearing rocks and veins. The water issues from the steep hillside as one or more ferruginous springs. Limonite is deposited around the spring, on the marshy slopes, and in the creek bottom. A character sample taken by the Bureau of Mines October 4, 1957, assayed 51.1 percent iron, 0.05 percent phosphorus, 1.28 percent sulfur, 3.6 percent silica, and less than 0.1 percent manganese, and lost 20.5 percent on ignition.

A spectrographic analysis shows 0.001-0.01 percent lead and zirconium, and 0.01-0.1 percent copper, titanium, and manganese.

Large amounts of limonite reportedly were used in smelting at Durango before 1899.

Reference: (27, p. 9).

Summit County

Snake River Bog Limonite

Limonite bog iron occurs along the headwaters of the Snake River above Montezuma, in sec. 12, T. 6 S., R. 76 W., sixth principal meridian, Snake River mining district (location 98, fig. 1). Seven lode claims, the Iron King Nos. 1 to 7, were staked recently over most of the deposits. They were located by Leland and William Sharp, of Montezuma, and Charles Pattison, of Grand Junction. Production consisted of a small amount of ore used as flux at the Hall Valley smelter in 1875.

Limonite occurs as a variety of yellow, red, and brown hydrous-iron oxides in bog deposits along several unnamed, northwesterly trending drainages on the west slope of Red Cone Mountain, and along the swampy bottom of the Snake River Valley between altitudes of 11,500 and 11,900 feet. The deposits are observed along the old, corduroy Webster Pass stage road north of Landslide Peak and along the east side of the Snake River. The deposits are about 100 feet wide in the swampy drainage bottoms and extend about 1,000 feet up Red Cone Peak, and interruptedly along the Snake River for about 1 mile. The deposits are irregular, with observed thicknesses up to 10 feet.

Limonite occurs wherever ground waters have passed over the oxidizing pyritic rock of Red Cone Mountain. The iron is taken into solution and precipitated as limonite, goethite, and turgite in the swampy creek bottoms. The deposits are similar to those of Handcart Gulch and Hall Valley in Park County. Analyses of some fo the ore reported from various sources are shown in table 27.

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TABLE 27. - Analyses of limonite from Snake River deposits (percent)

Fe	P	S	SiO_2	Mn	Loss on ignition	CaO	Al_2O_3	Remarks
45.9	0.68	1.4	4.8	<0.1	25.0	-	-	Character sample by Bureau of Mines, 10/31/57.
44.45	.397	-	7.18	-	23.59	1.22	-	Raw ore used by Hall Valley smelter, 1875.
65.1	-	-	7.0	-	-	-	0.5	Burnt ore charged into Hall Valley smelter, 1875.

The workings are very old and caved. They consisted of shallow pits.

References: (12, pp. 266-273; 52, p. 571); (57, pp. 25, 54, pl. 3; 64, p. 144, map).

Miscellaneous Magnetite and Hematite

Magnetite and hematite are present as minor constituents of veins and igneous rocks in the Breckenridge district (location 99, fig. 1). They are not considered a commercial source of iron ore.

Blebs and coarse stringers of magnetite form part of the highly metamorphosed Jurassic Morrison formation on Prospect and Gibson Hills in sec. 32, T. 7 S., R. 77 W., Breckenridge (Bevin) mining district (location 99, fig. 1). The magnetite occurs with garnet, epidote, tremolite, and quartz on the north side of French gulch, just west of the Wellington mine. The magnetite can be traced for more than a mile but is too scattered to be considered a large source of iron ore.

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